THE HANDBOOK OF APARTMENT OPERATION

by Dan Fox, W2IQD

HANDBOOK OF APARTMENT OPERATION

A Complete Guide to Amateur Activity From Restricted Locations

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For Bonnie -- and the munchkins

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PREFACE

Any ham, in any circumstance, can set up a station and make contacts!

I know this is a strong statement, but I can back it up. Furthermore, I know that successful operation from restricted environments is a matter of applying a few simple but critical concepts, and applying them correctly. It is not necessary to be a rich engineer to take advantage of the ideas in this book.

Each year, more amateurs attempt to operate from less-than-ideal environments: apartment buildings, condominiums, rented houses, dorms, and other locations create serious operating problems. The unhappy result is that far too many hams either give up their hobby or settle for the haphazard, inefficient operating that brings more frustration than fun. This trend is increasing as more of our population moves into various forms of restricted housing.

This book represents an attempt to help amateurs living in apartment-housing environments to really enjoy ham radio. It contains what I have learned in over twenty years of activity from a variety of apartments, dorm rooms, condos, duplexes, rented houses, and other QTHs guaranteed to give any ham a case of the crazies. In addition to my own experiences, I have drawn on the ideas and methods shared with me by ham friends who are or have been operating from restricted QTHs.

INTRODUCTION

This is a how-to book.

Theory is fascinating stuff, and is necessary to thoroughly understand a subject. The theory behind the topics discussed in this book has been covered very well elsewhere; for readers who would like to know more I've made a list of some good theory-oriented texts in the Bibliography at the end of this book.

The discussions in this book occasionally require some reference to theory, however, and the theory that is discussed here is admittedly simplified. There are also areas of controversy, and when I am aware that controversy exists I have mentioned it.

There are few guarantees, but I can promise you this: no operating concept, antenna, procedure, or suggestion has been included in this book without first having been field tested and found successful by amateurs in similar situations. All projects and procedures are described with the beginner in mind, with no detail omitted. Even the most combat-hardened Extra Class ham may find ideas he can use, although the technical content assumes that the reader has only the equivalent of a Novice License,

This book can be read from start to finish, but each Chapter is fairly self-contained and a cafeteria-style approach will be useful to grab a quick idea or solve a problem.

Although antenna restrictions and radio-frequency interference (RFI) are the two most common and most-discussed problems confronting the ham who tries to operate from a restricted environment, I have covered all of the aspects of restricted operation in this book -- so it is not just an antenna book or a TVI book -- but, I hope, a true apartment handbook.

About the word "apartment" -- I have adopted two stylistic conventions. First, I refer to all hams operating from restricted environments as apartment dwellers. Second, I refer to the reader as "he." Of course, this book is not restricted to apartment dwellers, but is intended for hams operating from all restricted environments. I am also (happily!) aware that many hams, and I hope lots of my readers, are YLs. Both terms are employed for convenience -- the reader's and my own.

You can operate successfully from virtually any location -- and by successfully, I mean you can enjoy a good signal, make lots of solid contacts, work DX, and participate in contests. If you find this hard to believe, consider what some friends and I have done recently:

-Worked WAC with 100 watts input and a homebrew antenna mounted in the basement.

-Cracked DX pileups on 20-meter CW with 10 watts input and a random wire thrown into a tree.

-Ragchewed regularly on 40-meter SSB with a dipole mounted one foot above a tin roof -- using one watt input.

You will soon be able to add your own stories to this list, and do so with smiling landlord and friendly neighbors. That's what this book is all about.

Merrimack, NH

June 1981

CHAPTER ONE: EQUIPMENT SELECTION

This Chapter is intended for the reader who has not yet built or purchased equipment. Those of you who have already done so, raise your hands. You may be excused to Chapter Two.

WHAT'S AVAILABLE?

TRANSCEIVERS

The amateur equipment type used most today is the commercial transceiver. Let's take a look at their advantages and disadvantages.

Advantages:

1. They occupy a very small space.
2. Most are well-constructed and relatively trouble-free.
3. They are simple to tune and operate.

Disadvantages:

1. The less expensive models lack flexibility, especially when they are used without a remote VFO.
2. They are often extremely difficult and expensive to service.
3. They are expensive.

The major objection to transceivers is expense. If money is not a big consideration I don't think a beginner can go too far wrong with any of the better-known transceivers. Ham gear, thoughtfully purchased, is a good investment that provides an excellent cost-per-hour entertainment value. XYLs take note!

See the cautionary note on page 22 before you buy any rig.

Second-hand transceivers can be an excellent buy. Be careful, however, to make sure that the older rig has the features you want. Don't make assumptions! Many older transceivers were not really intended for CW operation -- there is no provision for a narrow CW filter, a necessity on today's crowded bands. A few old transceivers don't even transmit and receive CW on the same frequency! I nearly went nuts a few years back trying to figure out why a friend's vintage transceiver wasn't getting out on 20 CW. It was -- two KHz away from the receive frequency.

To sum up transceivers, remember that they are expensive but an excellent investment. Check features based on your operating preferences, especially with older gear. If you love SSB but hate CW, you stand a better chance of getting satisfaction with older transceivers, which are usually SSB-oriented.

SEPARATES

Rigs with the transmitter and receiver in different boxes are often called separates. Most manufacturers no longer offer separates; a few sell very expensive receivers that can be combined with a transceiver for an elegant and versatile station. Most hams buying separates today will, therefore, be purchasing second-hand gear.

Let's consider two classes of separates:

1. Relatively modern equipment with separate transmitter and receiver, but with transceive capability (one VFO can control both transmit and receive frequencies).

2. Older equipment, mostly designed around tubes, with separate VFOs and no transceive capability. Modern separates -- the first category above -- represent to some hams (including me) the best of both worlds. They offer the flexibility and versatility of a separate transmitter and receiver (independent mode selection, good selectivity, and two VFOs). They also provide the invaluable benefit of a fully-integrated, transceiving station. Their only disadvantage is a small increase in required space. Individual needs vary, but I find this combination hard to beat.

Older separates, including the vintage gear from days of yore, present problems -- and some real delights. Let's check out the advantages and disadvantages:

Advantages:

1. Pleasure gained from operating vintage radio equipment.
2. Low cost.
3. Low cost.
4. Low cost.

Disadvantages:

1. Large size. This is bad for small apartments. Older gear is huge.
2. No transceive capability. The transmitter VFO must be manually tuned to the receiver frequency ("spotted").
3. Instability. Most older, tube-type gear is unstable by today's standards. This applies especially to equipment manufactured before about 1960.
4. Parts availability. Many replacement parts for older gear are no longer manufactured. By anybody, anywhere.

These are serious disadvantages, but your choice of equipment is important and there are situations where older separates are the best bet.

Size is self-explanatory. Whether or not you are pressed for space, never buy older, tube-type equipment sight unseen. If you are new to this, you won't believe how big and heavy that stuff is! If the space available for a rig in your apartment is at a minimum, older separates may just be too big.

Lack of transceive capability and inherent frequency instability does not interfere much with casual CW operation; in fact, many regulars on the 40- and 80-meter CW ragchew circuits wouldn't trade their old battleships for new gear at any price.

Phone operation, however, is another story. A growing and congenial group of hams likes to operate AM phone, and many of them use older equipment because the new gear doesn't include plate-modulated AM capability. But today most amateur phone operation is SSB, and this is where older gear most often falls short. Much of the early SSB transmitters were stable when in perfect adjustment (and after a long warmup period), but no longer want to stay put on frequency. Older receivers often require the operator to "walk down the band" with the transmitting station as his receiver drifts. These points must be seriously considered.

Finding parts to build and repair <u>any</u> piece of equipment is a nightmare for today's amateur. My eight-year-old rig uses a 12BY7 RF driver tube. The one I had installed was twenty-two years old, and one day it died -- in the middle of a contest, of course. I pulled it out, drove to my local TV shop, and presented it to the kid behind the counter.

KID: "What's that?"

ME: "It's a 12BY7."

KID: "But what <u>is</u> it?"

The shop owner's grandfather was called in for a consultation. The old fellow's eyes glittered as he fondled the dead tube. "Yes," he breathed softly. "I remember."

Maybe it didn't happen exactly like that, but you get the idea. It took several weeks for my tubes (I ordered spares) to come in. Obsolete parts can take you off the air for long periods of time; they can even render your treasured battleship useless.

Energy consumption is not a major consideration, since tube-type rigs don't draw enough current to make a siginficant difference in your electric bill. But old receivers and VFOs must be warmed up literally for hours before they become even marginally frequency stable. This does add to electric bills and to inconvenience. Before the days of the transistor, many hams used to simply leave the receiver and the VFO on continuously.

If older ham equipment is such a pain, why mention it at all? Who needs it?

You do, if you fit this profile:

1. Very limited budget
2. Prefer casual CW operation, especially on 40 and 80 meters
3. Lots of space for the rig.

In a crunch, old gear gets you on the air when all else fails. Besides, it's a bit like driving a vintage car!

ANYONE FOR QRO?

High-power operation -- defined here as anything over the 200 watts or so supplied by most transceivers -- is definitely not recommended for apartment operation.

The primary reason for this flat statement is RF Interference (RFI). As you increase your transmitter power, interference to TV, stereo, and other equipment increases drastically. It just isn't worth it. Further, high-power operation requires special considerations, such as heavier wire and cable, and a host of other details you simply don't want to be bothered with. Believe me, over about 100 watts any increase in power just isn't worthwhile for the apartment dweller.

RULE OF THUMB: FOR HAPPY APARTMENT OPERATION, ALWAYS USE THE MINIMUM PRACTICAL AMOUNT OF TRANSMITTER POWER.

This also happens to be an FCC regulation, so you'll be in good company!

BEFORE YOU BUY OR BUILD

If possible, the beginner or near-beginner should not attempt to buy amateur equipment without the advice of an experienced ham. This advice is essential when buying used equipment. Even when you are buying good used gear from an honest seller, you can get burned in many ways -- just by not knowing exactly what to look for, and what questions to ask. So get help. (Unless you're an oldtimer yourself!)

IN SUMMARY

A complete discussion of equipment selection is beyond the scope of this book, but I have listed a few major considerations involved in this complex subject. They will point you in the right direction.

You equipment-purchase decision should be based on:

1. Budget
2. Available space
3. Operating preferences

Two points are purposely skipped in this Chapter. First, I have not discussed building your own gear. Many hams still do, despite increased complexity and parts shortages. Kits, too, are great fun and increase your knowledge and skill. I consider this topic beyond the scope of this book.

Second, I have elected not to mention any equipment manufacturer by name -- for any reason. It seems that whenever I name names, even to praise, somebody gets honked off at me. Who needs it! Ask around about manufacturers and equipment. You'll get plenty of opinions.

CHAPTER TWO: ASSEMBLING YOUR STATION

WHAT YOU NEED

Now that you have the transmitting and receiving equipment of your choice, or at least have a good idea what it's going to be, another important question must be answered: Those station accessories so often mentioned -- what are they? What is really necessary, what is optional, and what is expensive luxury?

There are certain accessories that are essential for successful apartment operation. They are the devices that enable you to load your rig into a non-resonant antenna, and to eliminate interference with other electronic equipment. These accessories are:

Antenna tuner (transmatch)

SWR bridge with relative power meter

Low-pass filter

Ac power line filter

Antenna switch

Dummy load

Each device plays an important part in the successful operation of an apartment station. Let's look at them one at a time.

It is important to note first, however, that several of these devices are available as a single unit. This is a tremendous convenience and space-saver for the apartment ham, and I recommend these units. If you'll be building your accessories, it is well worth the extra time and trouble to design them

into a single box. These combination devices are designated primarily as antenna tuners, but they also include:

SWR bridge and relative power meter

Antenna switch

Dry dummy load

Who says nobody cares about the apartment ham!

ANTENNA TUNER

Later in this book, we will see that the non-resonant antenna is virtually a must for effective apartment operation -- even if ample space is available. Non-resonant antennas -- antennas operated away from their single naturally-resonant frequency -- must be operated with an antenna tuner.

An antenna tuner is an impedance transformer. Some types are popularly called transmatches; for simplicity we will use the term "antenna tuner" throughout this bonk. All antenna tuners perform the same task: they match the impedance of an antenna to the output impedance of your transmitter. Almost all modern transmitters are designed to operate into a 50-ohm, unbalanced load, so any antenna that does not present this load must be connected through an antenna tuner.

SWR BRIDGE

An SWR (Standing Wave Ratio) bridge is a measuring device that indicates, indirectly, how well your antenna/feedline combination is matched to your transmitter. It does this by indicating the ratio of forward to reflected power present in the transmission line (or wherever it is connected).

SWR bridges are used effectively to monitor the characteristics of all types of antennas. They are also used in conjunction with an antenna tuner to determine the correct tuner settings. An antenna tuner is next to useless without an SWR bridge!

DUMMY LOAD

A dummy load is a big resistor that does everything your antenna does -- except radiate. I consider a dummy load a necessity for any station. Not only should you be able to tune up and test equipment off the air, but you should also have a known reference "antenna" to isolate antenna problems from rig problems.

Dummy loads are, as I said, just big resistors. Some are not so big: if you run super QRP, a one-watt resistor is an adequate dummy load!

Light bulbs have been used by many hams in years past, but they have some problems. Their impedance is not constant with frequency, and also changes as power is applied. In a pinch, you can use a bulb (with tube-final rigs only) that is rated at about the <u>input</u> power of the rig. Using a 60-watt bulb with a 150-watt transceiver will only blow the bulb.

<u>WARNING</u>!

<u>NEVER</u> USE A LIGHT BULB AS A DUMMY LOAD WITH TRANSMITTERS HAVING SOLID STATE FINALS! THESE ARE THE "NO TUNE-UP" RIGS. THE FINAL AMPLIFIER MAY BE RUINED.

At power levels above a few watts, the resistor that is used as a dummy load must be coupled to a heat-dissipating device of some kind. The two device types readily available to amateurs are oil immersion and the solid

heat sink ("dry dummy load"). For apartment use at moderate power levels, I think the dry devices are superior: they are compact and there's no oil to spill on the carpet. Dry dummy loads also come in inexpensive, low-power models, and some are built into antenna tuners -- an advantage I favor.

LOW PASS FILTER

A low pass filter attenuates your HF transmitter's RF output above about 30 MHz, reducing television interference caused by harmonic and stray radiation.

Unless you have no neighbors you need a low-pass filter. And if you have no neighbors shut this book and go back to your antenna farm, you lucky dog! The rest of us must use a low pass filter.

AC LINE FILTER

An ac line filter prevents RF from your transmitter from entering power lines and causing interference with other electronic equipment.

This filter is of great importance to the apartment dweller who shares a common electrical system with other tenants. It is one thing to have the XYL complain that you're wiping out her favorite radio program. It is quite another to have the neighbors pounding on your door, as we will see in Chapters Ten and Eleven.

ANTENNA SWITCH

A good coaxial switch is a must, even if it only switches between the antenna tuner and dummy load. You won't believe how easy it is to screw up

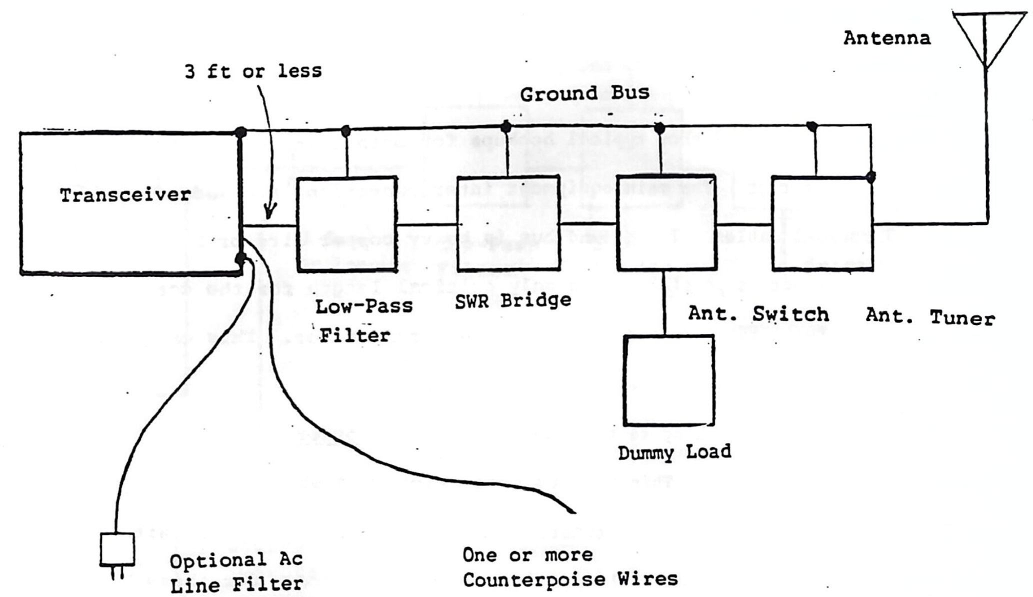


FIGURE 2-1: TRANSCEIVER HOOKUP, WITH ACCESSORIES

coax connections when you're trying to make a quick switcheroo until you've tried it. As with all devices in the RF-transmission sequence, don't buy junk. Some of the plastic garbage on the market for CB will eat up your precious power through resistive switch contacts and poor workmanship, then fall apart when you need it most.

CABLING AND HOOKUP

Now that we know what we need, how do we hook it up?

Figures 2-1 and 2-2 show typical hookups for both transceiver-based and separates-based rigs. The main equipment interconnections are made with RG-58 or RG-59 coaxial cables. The ground bus is heavy copper wire or braid, and should be as short as possible. The only critical length for the coax is the connection between the low-pass filter and the transmitter. This cable should be as short as possible, and never more than three feet.

The most important thing to remember is that the <u>order</u> in which the components are connected. This must be done exactly as shown in the figures, or your rig won't work. Antenna tuners with integral SWR bridges, switches, and dummy loads will automatically provide the correct order for these components.

Antenna and ground connections are discussed fully in later chapters. And if you don't know a coax connector from a ground bus, don't worry -- that's coming up later in this Chapter.

PHYSICAL STATION ARRANGEMENT

The placement of various equipment in your ham station is more important than you might think. In addition to operating ease,

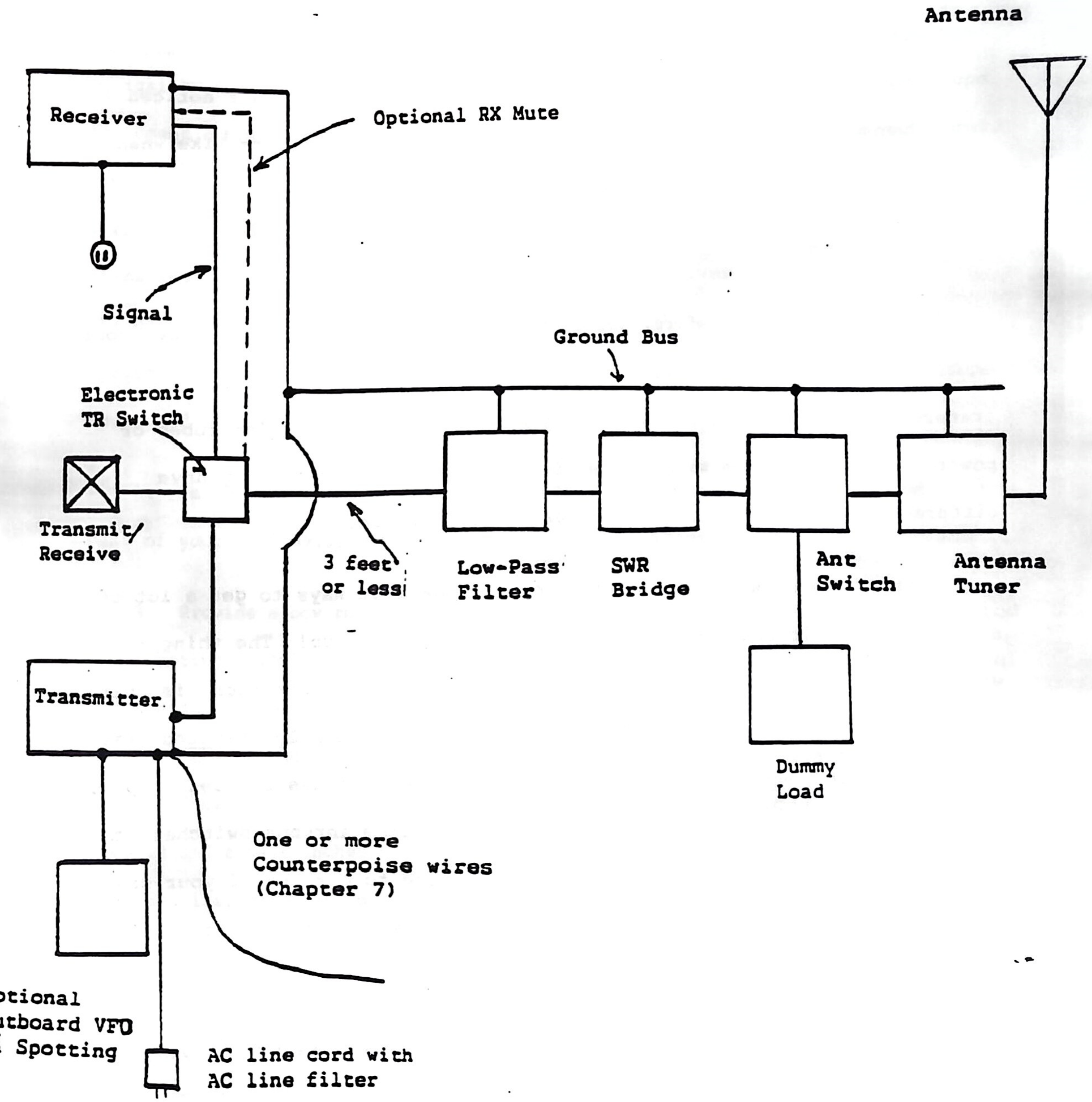


FIGURE 2-2: SEPARATE TX/RX HOOKUP, WITH ACCESSORIES

improper equipment placement can cause heat problems and result in shortened equipment life, especially for transmitters. In case you haven't noticed it yet, when equipment fails it always does so at the worst time -- like when that rare DX station comes back to your call.

STACKING RULES

I've mentioned this before, but it's worth repeating. It could save your equipment. Leave at least two inches of breathing space around your transceiver or transmitter, or any equipment with heat-generating tubes or power transistors. Some solid state rigs with rear heat sinks may have different or special requirements -- read those manuals.

Stacking pieces of ham equipment is one of the best ways to get a lot of station into a little space: when in doubt, go straight up! The thing to watch out for when you are planning, in addition to heat generation, is that you don't get tuning dials and other knobs that are frequently adjusted (as opposed to just touched) up so far that your elbow must leave the desk top to reach them. Knobs that are only used infrequently, like antenna switches, can be higher up, but try not to put them where you have to get out of your seat to make changes. Items like keyers and speech processors can be stacked tight and placed wherever convenient.

You will probably experiment with several arrangements before finding the one that suits you best.

DIMENSIONS

Most of us aren't lucky enough to be able to design an operating desk or console for our own use. But in most cases we have some control over the more important dimensions.

1. Breathing space. Transceivers and transmitters must never be shoved up against a wall or shelf, or another piece of equipment. In fact, any equipment containing power (and heat) generating tubes or transistors, should have breathing space. For proper airflow allow at least two inches of airspace around all sides of the equipment, and leave the top free. Never stack another piece of equipment on top of a transceiver or transmitter. (Exceptions may be made with certain solid-state rigs, but check your operator's manual first.) It is okay to place your transceiver or transmitter on top of other equipment, however.

2. Watch your rear. Don't forget that cables have to be connected to the rear of your equipment. Allow a minimum of six inches for this.

3. Provide elbow room, or you will be miserable after a very short period of operating. You'll need space for tuning the receiver, writing things down, and operating the key. Except during ragchews, most of your hamming time is spent twiddling the receiver dial. If possible you should have at least 17 inches of desk space in front of the rig. I'm tall, with long arms, and I have 18 and a half inches of desk space (I just measured it). Logbook, note pad, pencils, mike, key or keyer, lamp ... all take up a lot of space, even in a modest station.

EQUIPMENT LAYOUT

If you operate CW, you will want to lay out your station so that your dominant hand, the right hand for most people, easily reaches the key and pencil. Usually the non-dominant hand takes care of other commonly-used controls, such as receiver tuning. Most operators who use transceivers like to put them slightly offset to the left on the operating table (or to the

right if you're left-handed, as I am). Less-used adjustments such as keyer speed go on the left for a right-hander.

Another way to say all this is: put the most-often used control in the most convenient spot, and work down from there. A lot depends on the kind of operating you do. A SSB ragchewer who hates CW doesn't have to worry about key placement. A contest nut has keyer-memory buttons to push and thirty pieces of paper to keep up to date.

A comfortable chair is a must, and people who smoke should have a <u>large</u> ashtray nearby. A separate stand for drinks and snacks is nice if you can swing it, especially for long operating stints. Nothing is more demoralizing than spilling coffee onto log sheets or -- horrors -- into the finals of that new rig.

MAKING COAX CABLES THAT WORK

Why a whole subsection on cable-making?

RULE OF THUMB: NOTHING A BEGINNER DOES CAUSES MORE RIG PROBLEMS THAN BAD COAX CONNECTIONS.

This section might be called Stalking the Wild PL-259 or, How I learned to Stop Worrying and Love to Solder Connectors.

Coaxial cable <u>must</u> be used for RF interconnection of your components, as shown in Figures 2-1 and 2-2. Never try to use anything else.

This procedure will take you step-by-step through the process of making trouble-free coax cables for your station. Follow these cookbook instructions and you won't have to worry about shorted or lossy connections.

PREPARATION

1. Today, nearly every ham rig uses type SO-239 coaxial connectors. If you are in doubt, look at the RF output connector on your rig. If it says SO-239 or 83-IR, you are in business.

2. For each cable you'll need two PL-259 connectors, and two type UG-175/U reduction adapters for the small-diameter coax we'll be using.

3. <u>Sketch</u> your equipment layout and figure how much coax you'll need. Add several feet for good measure. (You can always find uses for coax.)

4. <u>Use RG-58U</u> coax -- the small stuff. Slight differences, such as RG-58AU, are fine. You can also use RG-59U, which has a somewhat larger diameter and requires a different reduction adapter, the UG-176/U. RG-59U has an impedance of 72 ohms instead of 52 ohms and will accept more power. Neither consideration is important here, but be consistent -- use the same impedance throughout. And get the right reduction adapter! Extra trips to the store are <u>not</u> fun when we're anxious to get on the air.

5. <u>Measure</u> each length of coax you'll need for equipment interconnection, and add a few inches for slack and for connector attachment. Cut the pieces and set them aside.

6. <u>Assemble</u> your tools. There aren't many, but they are important. You need:

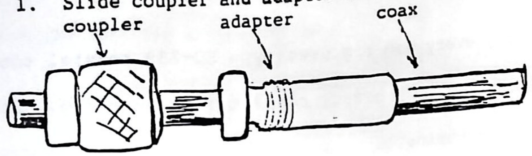
Utility knife

Longnose pliers

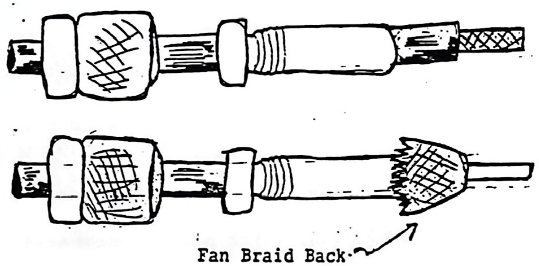
Soldering iron and solder (rosin core only)

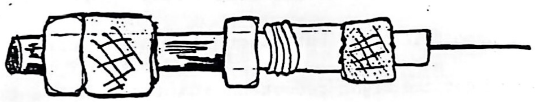
Diagonal cutting pliers or small scissors

1. Slide coupler and adapter over coax

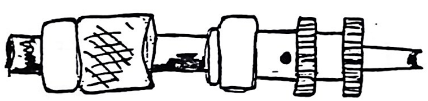


2. Cut 3/4" vinyl insulation from the end of the cable and fan the braid back over the connector.





3. Trim the braid and remove 5/8" insulation.



4. Screw on body plug and solder.
solder, cut excess wire.

FIGURE 2-3: MAKING COAX CONNECTIONS

ASSEMBLY

Follow these steps for each connection. Refer to Figure 2-3.

1. Pass one end of the cable through the coupling ring and slide the adapter on the cable as shown. DON'T FORGET THE COUPLING RING!

2. The narrow end of the adapter must face the end of the cable. Use the Utility knife to cut 3/4 inches of vinyl insulation from the cable. Be careful not to nick the braid. Now, fan the braid out a bit and fold it back over the adapter.

3. Trim the braid with the cutting pliers (small scissors will do) enough for a good fit about the barrel of the adapter. Then remove 5/8 inches of insulation from the center conductor. BE CAREFUL NOT TO NICK THE CENTER CONDUCTOR! Use the utility knife for this.

4. Tin the center conductor. Don't use too much heat, or the insulation will melt and you'll have a useless mess.

5. Screw the body plug onto the adapter. Be careful not to twist the coax; little bits of braid can cause shorts. The center conductor should pass through the plug center pin. You should see the outer braid through the holes in the side of the plug. Solder the braid through the side holes, then solder the center conductor to the plug pin.

6. Allow a few minutes for things to cool before you touch the connector! Then slide the coupling ring down over the plug and screw it into place.

This might seem like an awful lot of trouble to go to, just to explain cable connections. But this is where station trouble can occur -- often intermittent and hard to track down.

I can tell you from bitter personal experience that good coax fittings are worth the time and trouble.

TESTING

We're not quite done! Every coax connection must be tested. For this you will need an ohmmeter. (Inexpensive models are available for less than ten bucks at popular electronics outlets.)

1. Test the outer conductor (connector shell) for continuity (closed circuit or zero resistance).

2. Test the inner conductor (center plug) for continuity.

3. Check the outer-to-inner conductors for shorts. You should have an open circuit (infinite resistance).

RULE OF THUMB: IF YOU ENJOY PAIN AND MISERY, PUT LOTS OF UNTESTED COAX CABLES EVERYWHERE IN YOUR STATION.

CHAPTER THREE: YOUR ANTENNA -- INDOORS OR OUT?

INTRODUCTION

This is the first of several chapters that deal with antennas and antenna systems. I'm not going to spare any detail in this area, because your antenna makes or breaks your station.

If you are new to ham radio, let me give you some good advice: your antenna is the most important part of your station. Without a good antenna you can spend thousands of dollars on elaborate equipment and get aced out every time by the fellow with a homebrew ten-watter held together with Band-Aids -- a fellow who has a first-rate antenna.

Since this book is for hams with restricted QTHs and not much antenna space, our investigations into what makes an antenna good will have to be somewhat ingenious. The ham with lots of outdoor acreage has only to decide which high-gain array to put skyward. Since we don't have that luxury, every avenue must be explored.

The first item of antenna business, and the subject of this chapter, then, is general location. Will your antenna be indoors or out? Let's look at the factors involved in this major decision:

1. Building frame -- metal or wood?

2. Inside space available, including attic or crawl space.

3. Outside space available, including vertical, horizontal, and angled space.

4. Town, neighborhood, and building restrictions and attitudes.

5. Your own personal situation and preferences.

BUILDING FRAME

Nearly all modern apartment buildings are constructed around steel frames. If this is your (unfortunate) situation you can forget about indoor antennas. But don't despair -- outdoor, invisible, disguised and combination antennas will come to your rescue.

If your building has a wood or other non-metallic frame, seriously consider an indoor antenna system. If you have access to an attic or crawl space, this advice goes double. The long, straight antenna wires you can string there will give your signal lots more punch than a poor outdoor system.

INSIDE SPACE AVAILABLE

Many indoor antenna system stake advantage of moldings along hallways, or room-to-room runs. A square loop around a single room is popular, especially on the higher bands. See if you can run a wire along the molding or corners of your place for at least 30 feet without too many bends greater than 90 degrees. Look in every possible area.

A good general rule for wire antennas, indoors or out, is: avoid sharp bends if you can, but the longer the better.

While writing this book, I am doing a lot of operating with low power and indoor antennas -- just to keep my hand in. I did the apartment bit for 24 long years, but I want the problems and feelings fresh in my mind while putting this on paper.

Occasionally my ten-foot indoor wire and 50-watt transmitter come up with some nice surprises. The other night I heard SM7NZ calling CQ on 15 CW. I returned the call and Tor came right back with a 569. I immediately started bragging about my piece of hookup wire on the bench -- Tor was using a rectanglar indoor loop around a small room. He lives in a brick house, too! To top it off, Tor was using even less power than I was.

Do you really think you need a beam and high power?

OUTSIDE SPACE AVAILABLE

See how much outdoor space you have in a nearly-straight run. A few dog legs are okay -- the fewer the better. Again, sharp bend should be avoided. Remember that the space in which you string an antenna can be vertical, horizontal, angled, inside, outside, or any combination of these. Outside, there should be as much separation as possible from large metallic objects, such as tin roofs or power wiring.

WARNING!

<u>NEVER</u> RUN ANY ANTENNA OVER, UNDER, OR CLOSE TO POWER LINES OF ANY KIND. ALL ELECTRICAL LINES SHOULD BE CONSIDERED DANGEROUS.

<u>Proximity to wooden objects, especially trees, presents no problem</u>. Trees hide your antenna wires and do not attenuate the signal appreciably.

LOCAL REGULATIONS

The regulations you'll have to consider and deal with might be informal and unwritten, as well as the kind that show up on official-looking documents. Read Chapter Eleven on this subject before you decide on an antenna system. For now, note that the regulations that must be checked are:

1. Lease restrictions
2. Town Ordinances and zoning regulations
3. Customs and tolerances of the neighborhood

RULE OF THUMB: ANY ANTENNA THAT GETS YOU SHUT DOWN IS NOT A GOOD ANTENNA.

What happened to Larry, KA2***, will serve as a sad lesson to all of us. Larry was set up for FB operation in a nice apartment building with a wooded area in the back. He had managed to run single-wire feedlines invisibly into the woods and was working piles of DX with multiple-wire antennas strung around the trees.

Larry got to figuring that, since things were going so well, the landlord and neighbors must know about his operation -- and were quietly accepting it, since the lease prohibited outside antennas. So he put up a very visible vertical antenna in the same wooded area.

Larry was off the air in a week. He is still off.

Lesson: Don't make assumptions and don't take risks. If doubt exists, use an indoor or well-disguised outdoor antenna system.

YOUR SITUATION AND PREFERENCES

What you will put up with, or what the XYL will tolerate, is up to you. But it's a good idea to get this decided and agreed upon before you start stringing wires! Keep in mind that there are some fairly terrific indoor and outdoor antennas that cannot safely be used in areas where there are children, pets, or late-night inebriates.

Make these decisions now ... before you commit to a plan of action.

RULE OF THUMB: AN OUTSIDE ANTENNA OFTEN BEATS AN INSIDE ANTENNA, BUT ANY ANTENNA BEATS BEING OFF THE AIR.

DESPERATE MEASURES

If you are in a particularly bad situation, don't despair! In 25 years I have never seen a situation where a signal could not be radiated. Trust me, read the rest of this book, and make room on the wall for all those certificates you are going to earn.

HANDBOOK OF APARTMENT OPERATION

CHAPTER FOUR: ANTENNA FEEDLINES AND WIRE ANTENNAS

To discuss feedlines now may seem like putting the radiation cart before the horse. In a conventional antenna book, perhaps it would be. Ordinarily we decide upon the antenna system we want to put up and use the feedline that provides the best match. The majority of conventional homebrew antennas -- and virtually every commercial antenna sold today -- use coaxial cable as the feedline. Now, if you had acres of real estate and a big antenna budget, you wouldn't be reading this book (if you do -- and you are -- thanks!). Faced with a different set of problems in antenna selection and setup, we must change our philosophy a bit.

The philosophy I'm promoting is controversial and will ruffle some feathers. Here it is: Unless you have ample space for full-sized outdoor antennas, I strongly recommend you <u>not</u> use coaxial cable at all for feedlines, except in a few special circumstances.

THE CASE FOR SINGLE-WIRE FEEDLINE

For some reason many hams think there is something "wrong" with using a single, continuous wire for both antenna and feedline. Such antennas seem incomplete, I suppose. Perhaps they appear too simple to those of us who are constantly exposed to commercial advertisements and construction articles that give the impression that 50-ohm coax is an inseparable part of every antenna system.

Nonsense!

Most commercial and homebrew antenna tuners produced today have provision

for single-wire feed, but too often they are not used -- especially by the apartment crowd, who have the most to gain!

Almost every time my friends and I have been asked to help a struggling apartment ham, the scene has been the same: the poor guy thinks he <u>has</u> to have a dipole, with coax, for every band -- no matter what! The nice part of these house calls is there are invariably a number of alternate antenna systems he can use for a superior signal and all-band operation.

Don't get me wrong. Most conventional, full-sized, outdoor antennas are a natural for coax feedlines. I use it myself, now that I'm a man of property! Properly employed, coax is weatherproof, easy to handle, and provides a convenient match for most commercal rigs. But its use severely -- and unnecessarily -- hampers us in our quest for effective, restricted-space antennas.

As a general rule, use coax feedline if:

1. You have lots of outdoor space

2. Only single-band operation is desired (but why limit yourself?).

WHAT KIND OF WIRE?

This area is neglected in most books, so I'll cover it here. We will begin with the good news that almost any kind of wire can be used effectively indoors. For this sort of antenna don't waste money on special "antenna wire" (whatever that is). Use what you can get. Unless it's very rusty, nicked, or full of sharp bends, used wire is fine .

Here are some tips to help you get the right wire:

1. Wire sizes go by gauge. The larger numbers indicate smaller diameters; small numbers the large diameters. For example, number 32 wire is very fine, almost like thread or hair. Number 20 is a "hookup wire" size often sold at hobby shops. Number 10 wire, on the other hand, is thick, bulky, and often used for heavy electrical wiring. If you are interested, your local electrical, tv repairman, or hardware store can give you more specific information. See the ARRL Handbook for wire tables and more gauge information.

2. Small diameter wire works well for indoor antennas. In fact, you should use it. Wire with a gauge number above 20 is easy to conceal is ideal for indoor, outdoor, and hidden antennas. The very small gauges are a bit harder to work with since they tend to get tangled like sewing thread. The very heavy gauges are clumsy, bulky, and very expensive. At power levels below around 200 watts very small wire, up to number 28, can be used with no real loss in efficiency.

3. Insulated wire is great, indoors and out. Plastic, rubber, or enamel-coated varieties are all fine. There is no effective difference.

4. Solid or stranded wire types are equally good. I personally like stranded copper wire with rubber insulation , as it is flexible and strong. It is relatively expensive in small quantities, but worthwhile for its availability and ease of use. It does not, however, come in sizes small enough to make it useful for invisible outdoor antennas.

5. DON'T use bits and pieces of old wire, soldered or (worse) twisted and taped together. Save yourself the grief.

WIRE ANTENNAS AND THE ANTENNA TUNER

In Chapter Two, we said that an antenna tuner was an essential part of the compleat apartment hamshack. There is a reason for this: with a good tuner you can load up darned near anything and get it to radiate. This becomes more evident later, in our discussion of desperation antennas.

By using an antenna tuner almost any antenna can be used on all the hf bands. You won't be limited by the requirement for separate dipoles, verticals, or whatever. And that's a big help. Trap antennas are okay, but you still need a big space.

The result of all this consideration is that if all, or a part, of your antenna system must be indoors, your best antenna bet is the reliable random wire. This wire is sometimes called the Marconi, Longwire, Lazy L, etc. All of these antennas act like the same piece of wire when they are placed at low heights.

CHAPTER FIVE: INDOOR ANTENNAS

You've decided on an indoor antenna. The rig is assembled and waiting patiently for you to connect something to it.

What do you do about an antenna?

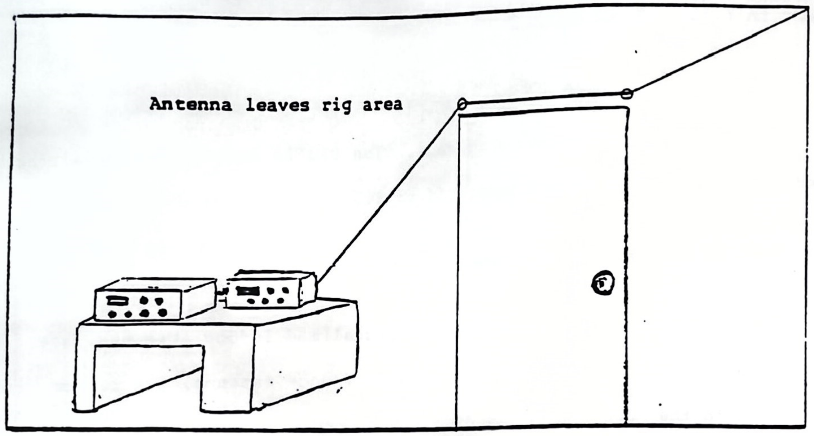
The random wire, as well as several specialized indoor antennas, are discussed in this Chapter. The best general indoor antenna, the random wire, is useful to the most hams and is discussed first.

THE RELIABLE RANDOM WIRE

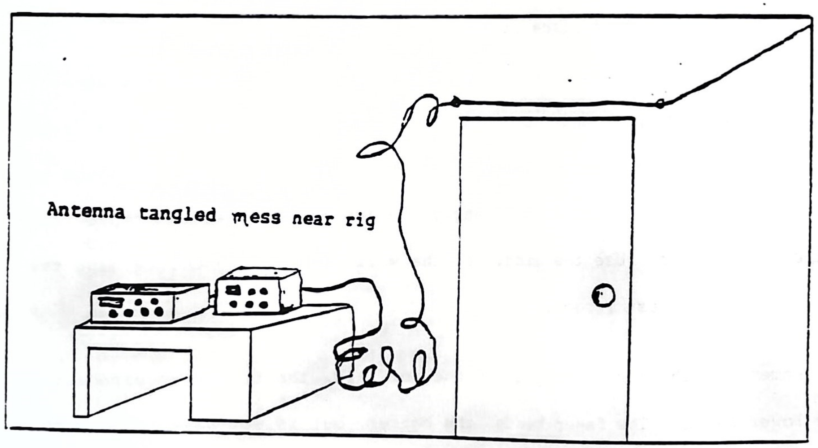
To find the best place to place your inside antenna, get your wire (or use string, if you prefer) and run it around the upper moldings of your apartment. See how long a run you can get with the fewest sharp bends. Bends <u>greater</u> than 90 degrees should be avoided; although you have to go around corners at that angle. Place the wire at the top of the walls if possible. Use the middle of the wall as a second choice, and the baseboards as a last resort.

Remember, the more wire you can use for this, the better -- especially on the lower bands. The fewer bends, the better, but if you have to go around corners to increase length, do so. Just avoid bends greater than the 90-degree corner bend.

Stay away from plumbing and electrical wiring -- it inductively couples to your antenna and absorb precious RF energy.



RIGHT



WRONG

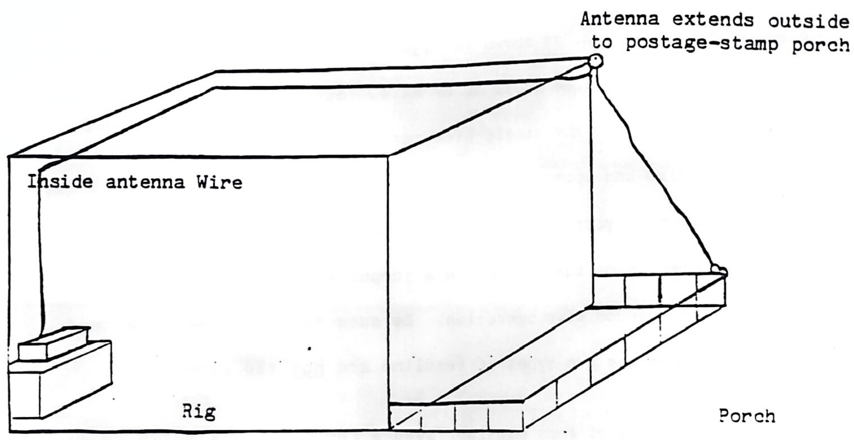
FIGURE 5-1: INDOOR ANTENNA PLACEMENT

Plot the course of your random wire, then put it in place using staples or small tacks. Don't worry about insulation or insulators; they're a luxury for outdoors. You aren't going to lose much power into wood or drywall anyway...but stay away from metal! As far as length goes, even a very short wire gets out and gets you QSOs, but the longer the wire the better.

Bring the end of the antenna wire directly to the antenna tuner, without tangles or doubling back, as shown in Figure 5-1. Take great care to do this correctly, or you will lose a bit of RF here. Scrape the end of the wire clean and connect it to the single-wire post of your tuner. Some tuners have both a single-wire and open-wire (balanced) connectors. They are not the same. Don't connect your random wire to either of the balanced line connectors. Also, some tuners require a jumper wire be connected or disconnected for random wire operation. Be sure this is done; the tuning configurations for the two types of feedline are <u>not</u> the same.

If you have a bit of room outside, even a few feet on a porch or patio, by all means extend your antenna (Figure 5-2). Feed the end of your indoor antenna through the window sash or other opening and connect it to the end of your outdoor wire. For a detailed discussion of outdoor antenna techniques, see Chapter Six.

A random wire does not have to be a single run of wire with only two ends. Endless variations are possible; a few are shown in Figure 5-3 just to stimulate your imagination. Soldering (always) more than one run of wire together gives you more effective length. This is especially profitable in apartments or other dwellings where it's possible to run several good lengths of wire by taking advantage of different rooms, hallways, porches, etc.



Even a few more feet of wire, especially outside, makes a difference.

FIGURE 5-2: GO OUTSIDE IF YOU CAN

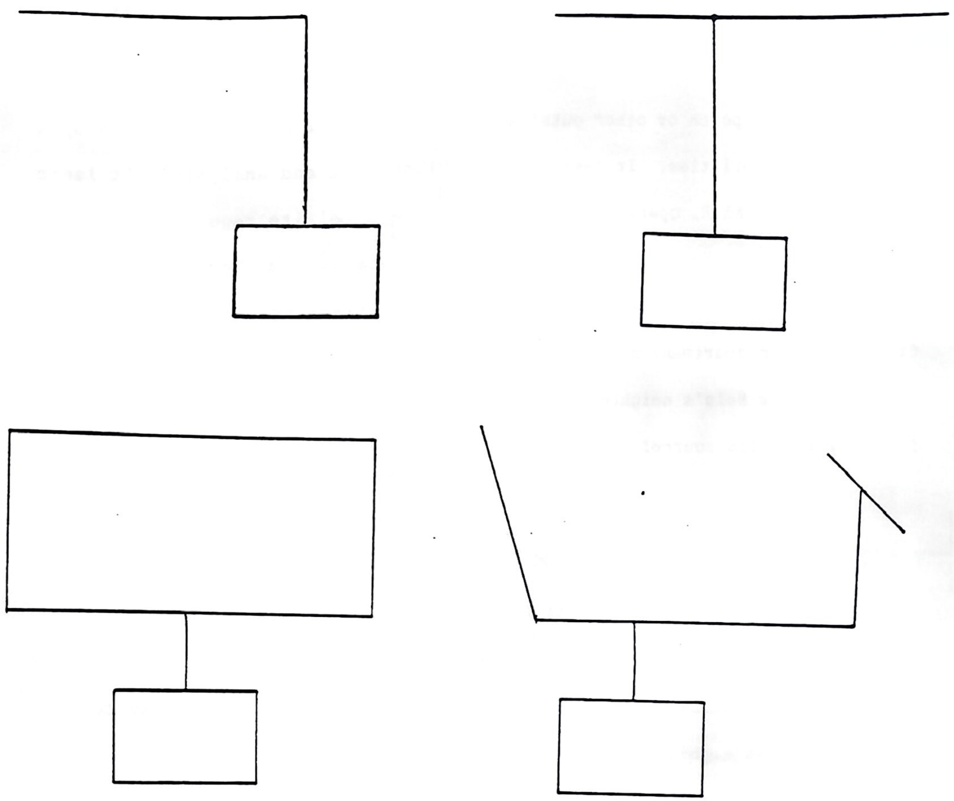


FIGURE 5-3: VARIATIONS HELP!

RULE OF THUMB: WITH INDOOR WIRE ANTENNAS, IT IS MORE EFFECTIVE TO HAVE ONE GOOD ANTENNA AND USE IT ON ALL HIGH-FREQUENCY BANDS THAN IT IS TO HAVE SEVERAL POOR RESONANT ANTENNAS AND USE THEM ON DIFFERENT BANDS.

Using your porch or other outside space, no matter how small, opens up a world of possibilities. It deserves careful thought and analysis! At least one ham, Nels, K1UR, operates through the OSCAR satellite regularly from his small apartment. He uses a complete AZ-EL antenna system that rotates up and down, as well as from side to side for satellite tracking. This antenna is fitted onto an apartment-sized terrace and is the larger 10-meter/2-meter type. I guess Nels's neighbors think he is tapping Home Box Office television directly from its source! The point is: use the space you have.

THE COIL, OR SLINKY*, ANTENNA

In the Preface of this book I said that I knew a ham who had earned his WAC (Worked All Continents) certificate with 100 watts and a basement antenna. Well, the antenna he used was an extended Slinky coil, the kind sold as a child's toy. The secret of the Slinky (or any other helical configuration, as we'll see later), is that it pack a lot of effective length into a small area. There is now a commercial version of this antenna advertised in the magazines, or you can build your own version, as shown in Figure 5-4.

Go to a toy store and buy the Slinky. Tell the clerk it's for your kid. Take it home and figure where you'll put it -- the coil can be placed at any angle, and works best when stretched out to at least ten feet. The length is

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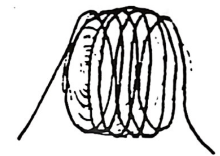
*Slinky is a registered trademark of James Industries Inc.

Child's Slinky Coil is only about three inches long when collapsed.



Extend to from 10 to 25 feet ,if possible

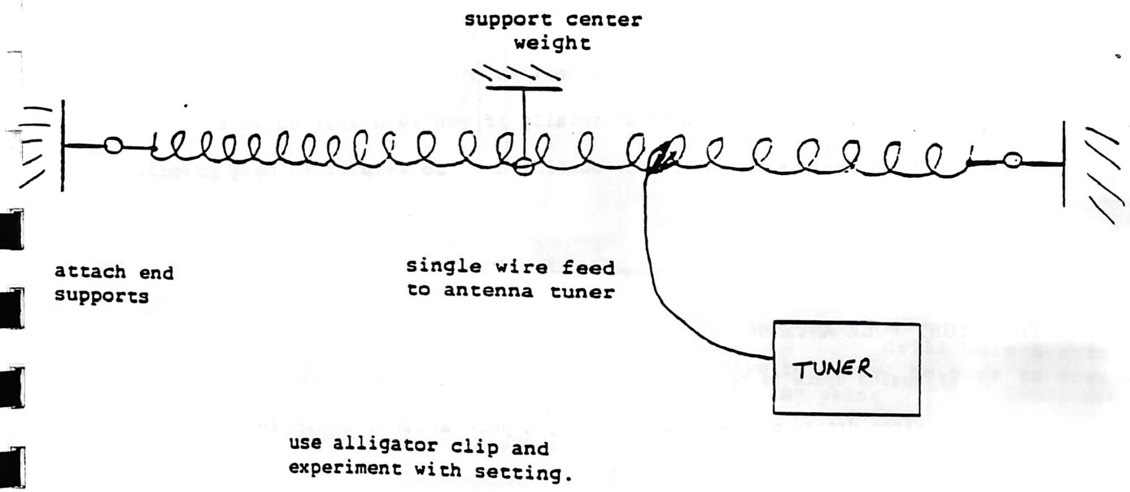


FIGURE 5-4: SLINKY COIL ANTENNA

not critical. When the time comes to shoot the juice to it (called <u>applying power</u> in more sedate texts), you can adjust the length to best advantage.

Tack the coil firmly in place, using good-sized tacks or small nails. If you have mounted it in a horizontal or angular position you may have to tack the center also, since the coil is much heavier than an equivalent run of wire.

To feed the antenna, run a single wire from your antenna tuner to the coil, and solder an alligator clip to the end of the wire. Now you can tap the coil antenna at any point. This is not only more versatile than attaching the feed wire directly to the coil, it avoids soldering to the coil itself, which is difficult.

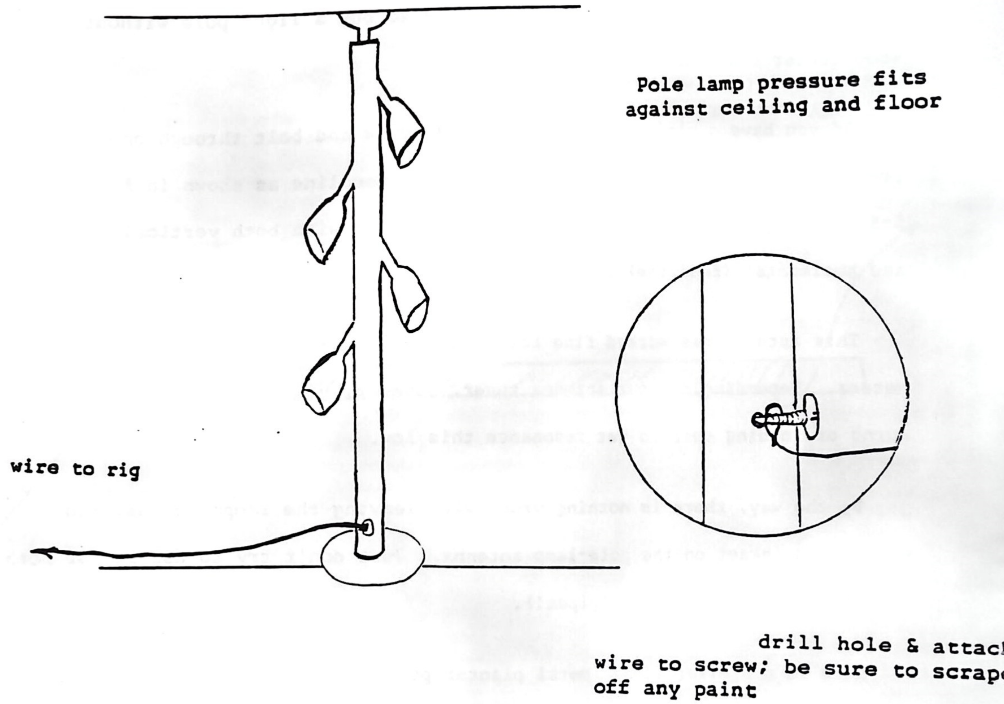
As with all antennas, get the Slinky coil as high as you can and keep it away from grounded metal objects -- especially if you're operating in a cellar! The antenna is also great for outside use, so keep it in mind when you read Chapter Six.

THE LIGHT POLE ANTENNA

If inside space is really tight and the XYL objects to all those wires draped on the walls, the light pole antenna shown in Figure 5-5 is a popular design that works well.

This is <u>not</u> an antenna to consider if small children or pets will be in the area while you are operating.

You can buy almost any kind of pole lamp -- any one will make a dandy antenna. They generally come complete with spring-loaded feet that permit vertical mounting between floor and ceiling. A word of warning, though: before you buy the lamp, check its <u>minimum</u> working height against the height



FIGRE 5-5: THE LIGHT POLE ANTENNA

of your ceilings. Some pole lamps now on the market are so large that only relatively high-ceiling rooms will accommodate them. Why the manufacturers do this is beyond me, but they do. Some poles come with wooden centers, which open up interesting possibilities for dipole experiments. If this sounds like something you'd want to try, you can also buy a light pole without the wood center and make a wooden plug for it.

If you have a plain pole, mount a 6-32 screw and bolt through one of the pre-drilled holes, attaching your single-wire feedline as shown in Figure 5-5. This gives you a simple, effective radiator with both vertical (pole) and horizontal (feedline) components.

This antenna has worked fine for a lot of hams -- all the way down to 80 meters. Depending on your antenna tuner, however, you might have to add a few turns of loading coil to get resonance this low.

By the way, there is nothing wrong with leaving the lamps, bulbs, and everything intact on the pole-lamp antenna. Just don't try to use it for both functions at the same time (yipes!).

Here is a similar idea: metal planter poles are now sold and should serve the same purpose, although I have no data on them. Experiment!

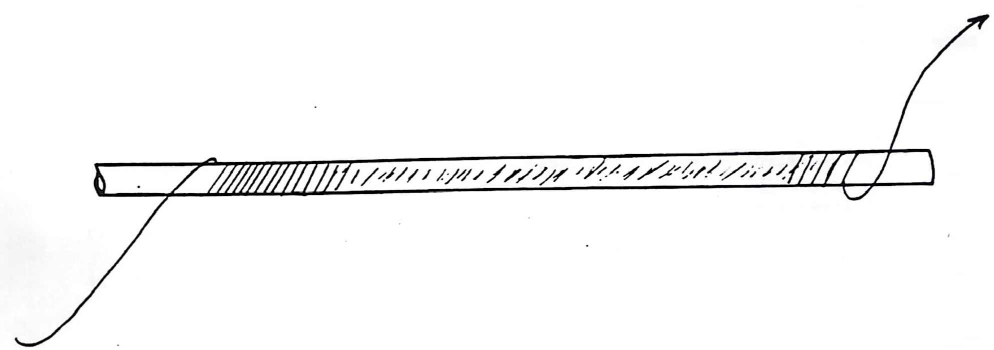


FIGURE 5-6: THE HELIX -- A USEFUL COIL

IN PRAISE OF THE HELIX

As with the Slinky coil, any helical configuration you can conjure up, inside or out, will increase your effective radiation. The trick is to wind the coil on a long, insulating form such as dry wood or fiberglass, and to keep the windings open as shown in Figure 5-6. Too-tight windings and multiple layers will absorb RF.

The helix can be used as an antenna itself, or as one end (usually the far end) of a wire antenna. For example, run some wire around your moldings as outlined earlier, then finish up with a helix out on the porch. The possibilities are endless.

Wood dowels are often used for helical forms. Another popular idea for less-obtrusive antennas is the fiberglass fishing rod. These come in a variety of sizes and colors and provide a good base as well as good camoflage. The helix provides an excellent basis for imagination and experiment.

IN SUMMARY

In this chapter on indoor antennas we have looked at a general type -- the random wire -- and a few specific types. Rather than lay down rules for antenna types, however, I would like this chapter to inspire your imagination a bit. I hope you can see that ten thick volumes could not include all the possibilities for indoor antenna systems. But once you know the few simple principles discussed here, you can have a lot of fun experimenting with your own systems.

CHAPTER SIX: OUTDOOR AND HIDDEN ANTENNAS

YOU CAN PROBABLY GO OUTDOORS

You can put an antenna -- or <u>part</u> of an antenna -- outdoors far more often than you think, so don't dismiss the possibility. This chapter explores the possibilities for outdoor antennas that can be invisible, hidden, or disguised, and well as standard in-the-open designs. Read it carefully before you make a decision or commitment.

In most cases an outdoor antenna is, of course, to be preferred to the indoor variety -- but not always! Take a good look at your location, both indoors and out. The ham with a long attic run in a wood-frame house and no real outdoor space often benefits more from a random wire in the attic than from an unsatisfactory outside antenna. Wood and fiber-based materials don't attenuate signals very much; height and length are the important things.

Our first consideration is available space outdoors. How much wire can you run, at any angle, without coming close to power lines or large metal structures? How high can you get it? Is there space and support for a vertical antenna? If you have a space of more than about 20 feet outdoors -- in <u>any</u> configuration -- it will pay you to try an outside antenna.

Our second consideration is the need for either disguise or invisibility of outdoor antennas -- they aren't the same thing! A disguised or invisible antenna will be necessary if, for any reason, you know or suspect that your neighbors or landlord will be less than ecstatic about your amateur endeavors.

An <u>invisible</u> antenna is either hidden or made of wire that can't be seen.

A disguised antenna is out in plain sight -- it just doesn't look like an antenna.

We'll discuss both antenna types in some detail. What you should decide now is: Will subterfuge be necessary? Chapter Eleven on landlords will help you make an evaluation.

Many locations lend themselves to some combination of indoor and outdoor antenna. You may be able to take advantage of this combination method to enhance your radiated signal. I've discussed this possibility in the last part of this chapter.

As with everything described in this handbook, don't be afraid to experiment a bit -- after all, that's part of the game.

OUTDOOR CONSTRUCTION PRACTICES

A somewhat different set of rules applies to the construction of outdoor antennas than to their indoor brothers. Outdoor antennas are subject to the weather. The effects of weather are both short term (wind) and long term (corrosion). Your outdoor antenna may be a modest, hidden wire, or your courtyard might look like a Russian jamming station! Either way, following a few proven construction practices will make the difference between an antenna system you can count on for solid performance, and a poor radiator that rusts out and falls down.

RULE OF THUMB: DON'T SKIMP ON ANTENNA CONSTRUCTION. IT ISN'T WORTH THE TROUBLE YOU WILL HAVE LATER.

TOOLS

You won't need all of these tools for every antenna you build, but they come in handy around the shack and are worth getting:

Soldering gun -- Use a dual heat gun in the 140/200 watt range for use with outdoor antennas. Pencil irons don't produce enough heat for this kind of work.

Long-nose pliers　　Diagonal cutting pliers

Wire strippers　　Small file

SUPPLIES

A few dollars spent on key items will save you hours of frustration building any antenna. Here is what you need:

Roll of rosin-core solder -- never use acid-core solder or paste fluxes.

Roll of electrician's tape

Roll of small-diameter nylon cord

Tape measure -- the longer the better.

MATERIALS

If there is no need to disguise your antenna, it pays to use a good grade

of wire. Number 16 copper, stranded or copperweld, will work well. You do not need very heavy wire, such as number 10 or 12, so don't waste money on it.

Insulators are beneficial and you should not go without them. Any of the inexpensive types available will work well or you can make your own from plastic or lucite. The more surface area between one end of an insulator and the other, the better.

CONSTRUCTION METHODS

I've begun this chapter this way because the tools, supplies, and methods we're talking about here will be of great benefit to you for any antenna you'll want to build, now or in the future.

Soldering

Always solder all antenna connections. Even if you can make what looks like a good, tight connection by twisting the wire, corrosion ruins it very quickly.

Use good soldering technique. Most beginners do not apply enough heat and produce a lot of cold joints. Excess heat can melt cable insulation. If you are in doubt, read up on soldering technique or get someone with experience to show you.

Always test each joint with an ohmmeter or continuity checker before you raise the antenna. Test is after soldering, then wiggle it around -- hard, as though it were in a strong wind -- and test it again. It is far better to find a bad joint while the antenna is on the ground and your equipment is already set up for soldering.

COAXIAL CABLE

If you have space for outdoor antennas you may be using coaxial cable, either with or without an antenna tuner.

NOTHING A BEGINNER DOES CAUSES MORE TROUBLE THAN BAD COAX CONNECTIONS.

Here is what you need to know to get coax working and keep it working:

1. Selecting Coax and Connectors

Quality. Lousy coax can eat up lots of expensive signal. It's false economy. Don't buy used, off-brand, or surplus coax; get the best you can from a reputable wire company. This is of utmost importance.

Get quality coax connectors -- brass, if you can find it. Stay away from cheap aluminum connectors.

2. Assembling and Using Coax

Making an end connection: Just as there's a hard and an easy way to attach a connector to the end of a piece of coax, there is the proper way to prepare the end of a piece of cabling to attach to your antenna. Doing it as shown in Figure 6-1 will save you a lot of grief. Here's how:

a. Using a sharp knife, cut about 3 inches off the outer jacket. Be careful not to nick the braided outer conductor.

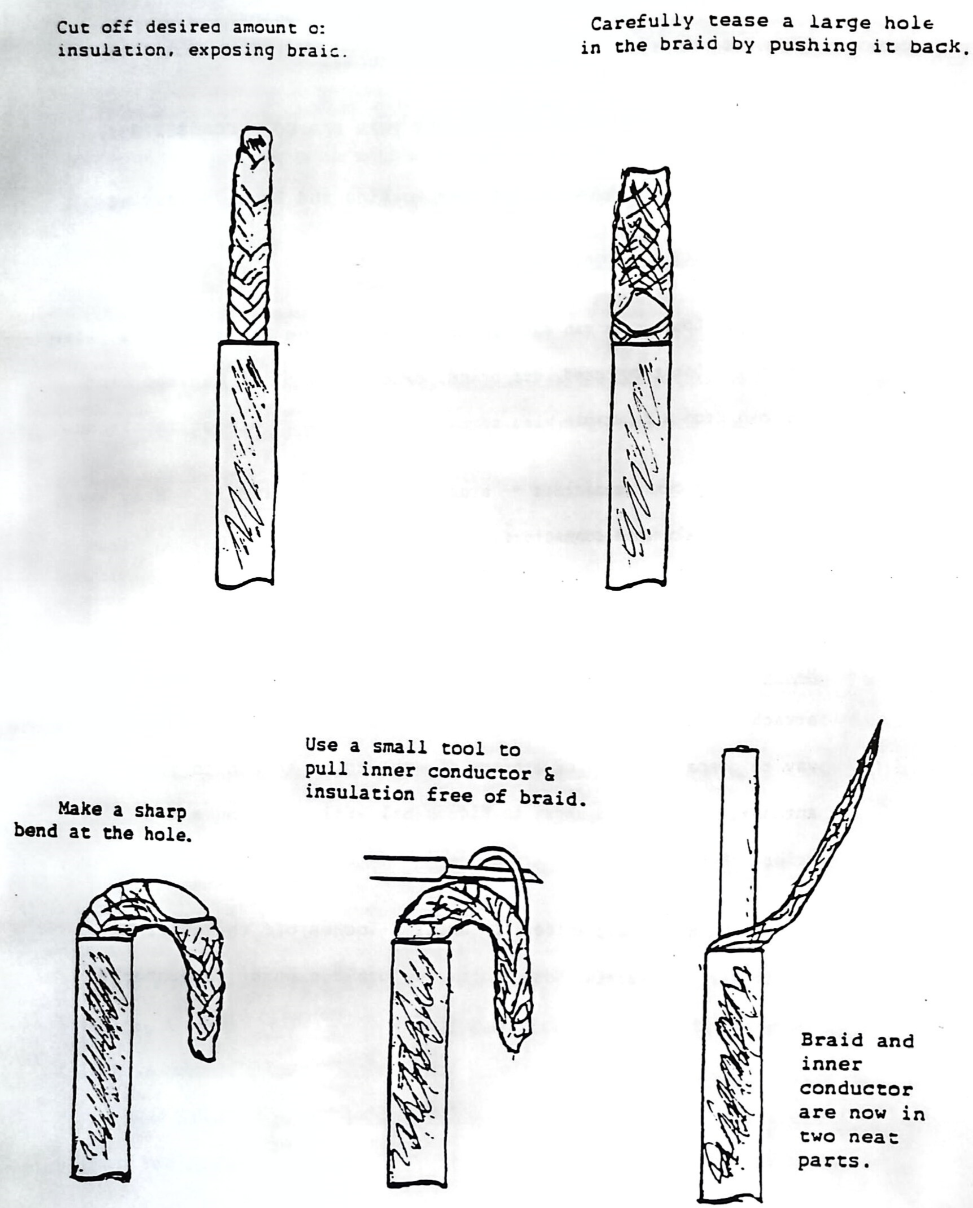


FIGURE 6-1: FORMING A COAX END

b. Make a hole in the braid as shown. Use a nail or small screwdriver to push the strands back until the hole is about the same diameter as the inner portion of the cable.

c. Bend the cable sharply in a U, as shown. Pull the inner conductor and insulation through the hole in the braid.

d. Remove about half an inch of the inner insulation from the end of the cable. Be very careful here -- a nick in the center conductor can create a frustrating, hard-to-find problem.

A few more steps are required to finish the job. We've come this far, so let's do it right. Finishing work requires tinning and weatherpoofing:

e. Tin the center conductor.

f. Using a sealing compound such as RTV or any silicone sealant, plug up the open end of the coax as shown in Figure 6-2. Allow a few hours for the stuff to set or you'll have a mess.

g. Wrap the braid with electrician's tape, seal it, and tin the end as shown.

Okay! Our labors were worthwhile, because we now have correctly prepared coax cable. We won't have to worry when it rains or when the wind blows.

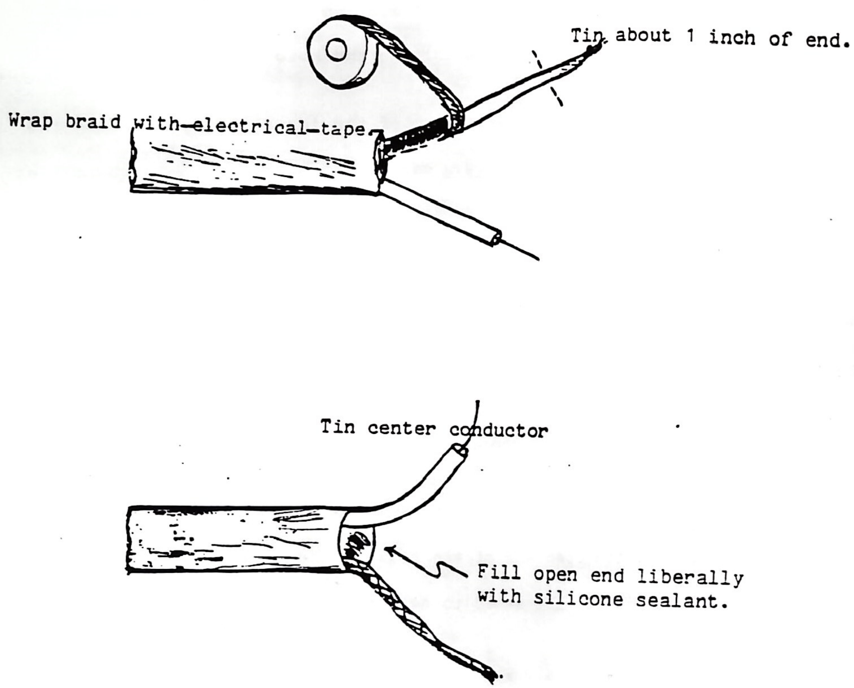


FIGURE 6-2: WEATHERPROOFING COAX

UNDISGUISED OUTDOOR ANTENNAS

This subject is covered quite thoroughly in other books. I'm going to say a few words about design and placement, describe a few of the best wire antennas, and cover some points not stressed elsewhere.

DIRECTIVITY AND GAIN

Your antenna selection and placement decisions should not be influenced by the wrong factors.

If you are reading this section it is probably because you have the space -- and the permission -- to erect full-sized outdoor wire antennas without bringing the world down around your ears. Before we go further, then, I must disillusion you a bit.

Many books and articles give the impression that even the simplest wire antenna is highly directive (which it is) and that this directivity can be used to advantage, as gain (which it can't). To be sure, if you erect a wire several wavelngths long, and put it at least one full wavelength in the air, it will be directive according to a predictable theoretical pattern. With short, low wires you can forget it.

What happens is this: Your radiation pattern is severely distorted by the ground and nearby objects and is impossible to predict. Put your antenna on the highest supports you can find and forget directionality.

RULE OF THUMB: PUT YOUR WIRE ANTENNA AS HIGH AND CLEAR AS POSSIBLE. FORGET ABOUT DIRECTIVITY.

WIRE ANTENNAS

The reliable, simple wire antenna has probably been responsible for more QSOs than all the other types combined. A few basic types are described in this section. All of them work well and put out a good signal.

Following a description of the antennas and how to construct them, I've added instructions on elevating them to awesome heights -- without climbing a foot!

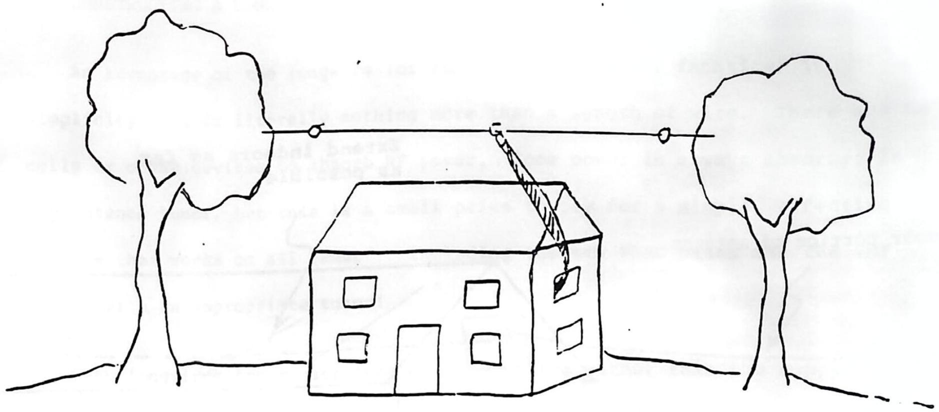
THE LONGWIRE (RANDOM WIRE) ANTENNA

Most antennas that are called longwires are not -- at least at the lower operating frequencies. To qualify as a true longwire, an antenna must be at least several wavelengths long at the operating frequency. "Random wire" is a better designation, since almost any reasonable length will work with a good antenna tuner. The terms "longwire" and "random wire" are used interchangeably in this book.

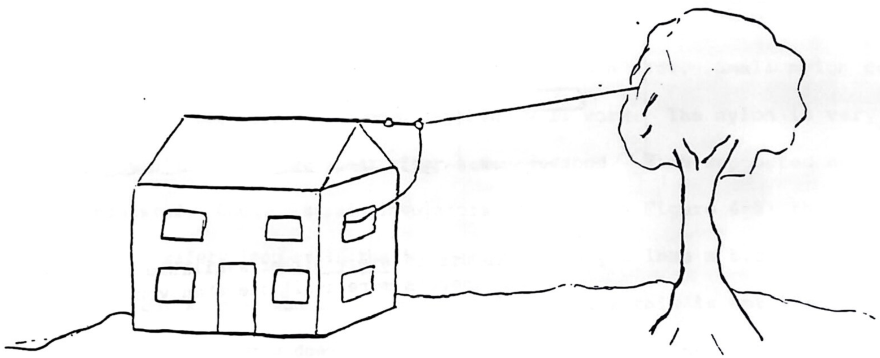
WHEN A LONGWIRE WORKS WELL

Consider using a longwire (or random wire) antenna when you have room for a wire antenna and your lot and building are placed so that a lead-in from the end will go directly to your shack. The big advantage of a longwire is that it is end-fed, providing easy installation in most instances.

Random wires can be fed at the center (or at any point, for that matter), but experience has shown that a wire fed in this manner can be cantankerous and hard to load up. If your layout lends itself to a centerfed wire you are probably better off with an all-band dipole, as described below. Figures 6-3 and 6-4 illustrate this.

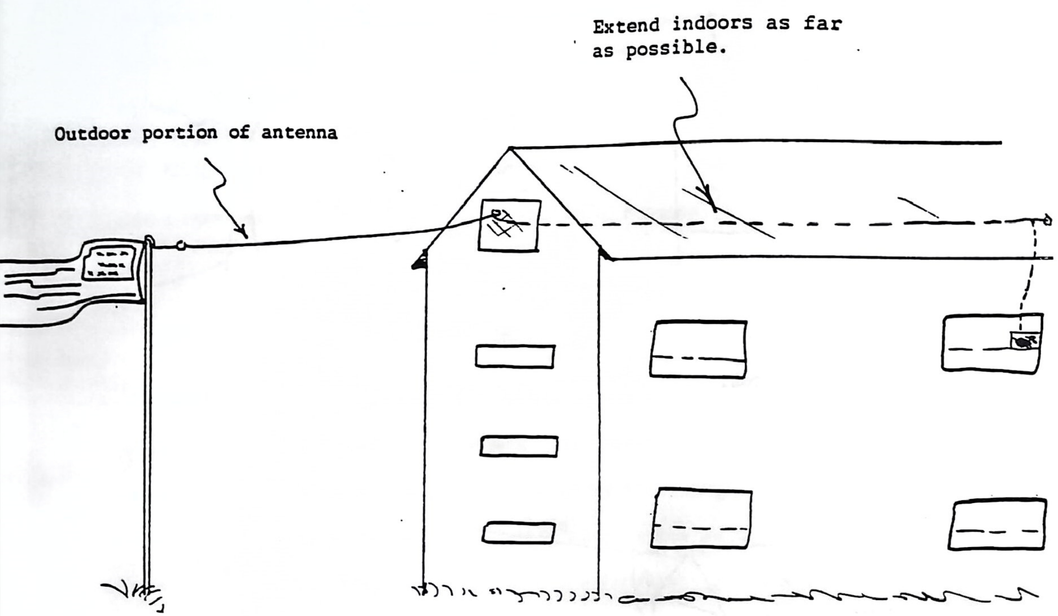


If trees are positioned like this, a center fed antenna is in order!



The case for an end-fed wire!

FIGURE 6-3: TREE CONNECTIONS FOR OUTDOOR WIRE



Make use of <u>every bit</u> of available space --
and there's more available than you think!

FIGURE 6-4: APARTMENT CONNECTION FOR OUTDOOR WIRE

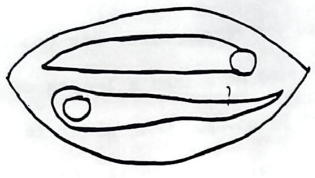
CONSTRUCTING A LONGWIRE ANTENNA

An advantage of the longwire (or random wire, for you fanatics) is simplicity. It is literally nothing more than a length of wire. There are no coils or other devices to absorb RF power. Some power is always absorbed in any antenna tuner, but this is a small price to pay for a simple, effective skywire that works on all bands -- including the new WARC bands and the VHF bands, with an appropriate tuner!

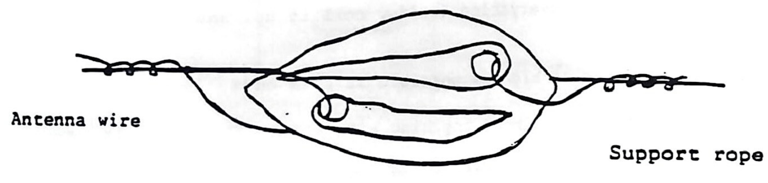
Many longwires are constructed of hookup wire rather than the copper wire designed for the purpose. This hookup wire comes in 80- or 100-foot rolls and is available at popular local suppliers. If you can run more than 80 or 100 feet of antenna, great! Just splice it using solder and electrician's tape. If possible, assemble everything inside, coil it up, and then put it up.

Support the wire as high as possible at both ends. Small nylon cord is best for this, although almost anything will work. The nylon is very strong and won't rot or come apart after a few seasons. Each supported end should be insulated. Connect strain insulators as shown in Figure 6-5; this way you have a safety loop -- if the insulator breaks you lose a bit of effectiveness but your antenna won't fall down. (If you think this is not important, wait until your antenna <u>does</u> fall down -- on a stormy, rainy night with you in the middle of a contest or a great ragchew!)

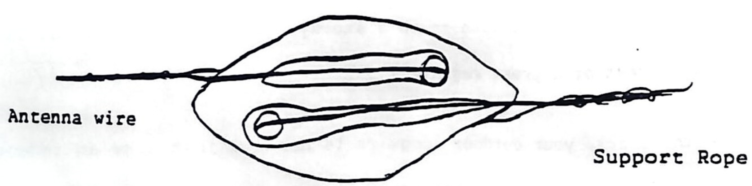
Inside the shack, your outdoor longwire is handled just like an indoor antenna -- in fact, this portion becomes an indoor antenna, part of an indoor/outdoor combination! Unlike coaxially-fed antennas, every inch of an end-fed wire antenna radiates. Keep the inside portion insulated from metal objects and wiring, and run it straight to the rig.



Strain insulator has grooves for wire and support.

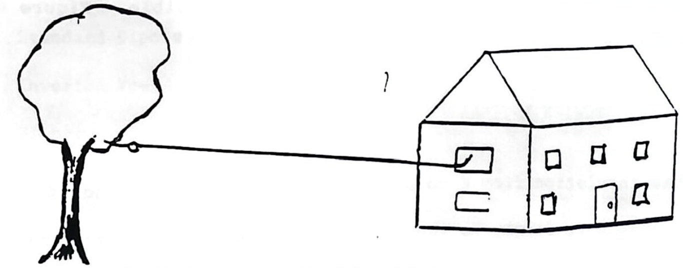


WRONG -If insulator breaks, the antenna will fall!

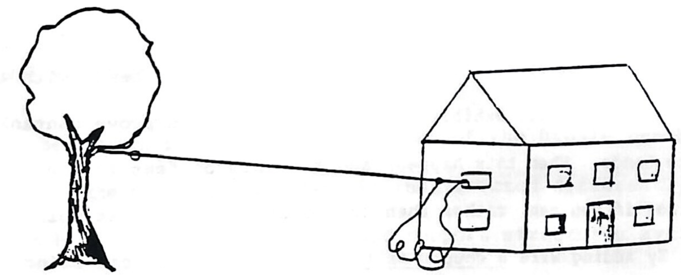


RIGHT -If insulator breaks the antenna stays up!

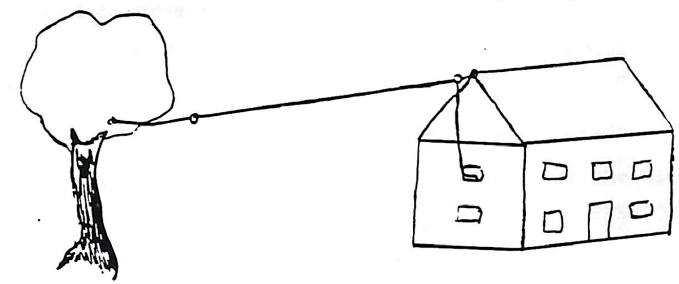
FIGURE 6-5: INSULATOR DETAIL SHOWING WIRE AND SUPPORT ROPE CONNECTION.



FAIR -Antenna could be higher.



POOR -Tangled portion causes high loss!



GOOD -Care has been taken to make maximum use of environment.

FIGURE 6-6: OUTDOOR WIRE ANTENNA PLACEMENT

Always get as much of a wire antenna as high as possible. Figure 6-6 shows right and wrong ways to go about this.

TESTING THE LONGWIRE ANTENNA

Remove the insulation from a couple of inches of the rig end of your antenna and connect it firmly to the RANDOM WIRE post on your antenna tuner. If you're new to this sort of thing, follow the instructions in Chapter Nine and tune up your rig on each band. Depending on the range of the tuner you're using, a wire over about 50 feet long should load up on all bands with a low SWR. Some wire lengths will exhibit chance resonances and prove cantankerous on one or more bands. When this happens add a couple of feet to the antenna. Always add wire, if you can, rather than cut it off. And please solder your connections! By adding wire a couple of feet at a time, you can bring the rebellious SWR to its knees.

You should not settle for less than operation on all hf amateur bands with this setup, because you can have it.

THE DIPOLE BROTHERS

This could also be called, "Welcome to Coax Country."

In the beginning of this book I shot off my big mouth and praised single-wire feed as opposed to coax. I still stick to that claim, for inside and for restricted outside antennas. But there are several good standard outdoor antennas that employ coax feed, and I'm including them here for your convenience.

The Dipole Brothers are:

Standard Dipole

Inverted Vee

Sloper

They are shown in Figure 6-7.

There are also all manner of uncles, cousins and distant relations in this family, from Folded Dipole to Delta Loop. They are not included here because of space limitations.

Don't be disturbed by the different names of the Dipole Brothers. They are basically the same antenna. Each is just erected differently. The one you put up is determined by the space and support structures available. None of the three antennas has a real performance advantage over the others. (This is a point of controversy; some hams disagree.)

The sloper is just a dipole with one support lower than another. Slopers work well with the low end very close to the ground -- eight to ten feet or less. The inverted vee has a couple of advantages over the dipole and sloper: first, it requires only one high support -- in the center. The ends can be as low as five or six feet from the ground. The second advantage is space -- the inverted vee takes up a lot less room than a dipole or sloper.

CONSTRUCTING THE DIPOLE BROTHERS

Constructing a dipole antenna requires a bit more work than assembling an end-fed wire, but it is simple and is easily done in an afternoon. This

W2IQD ... W2IQD ... These antennas ain't getting out ....

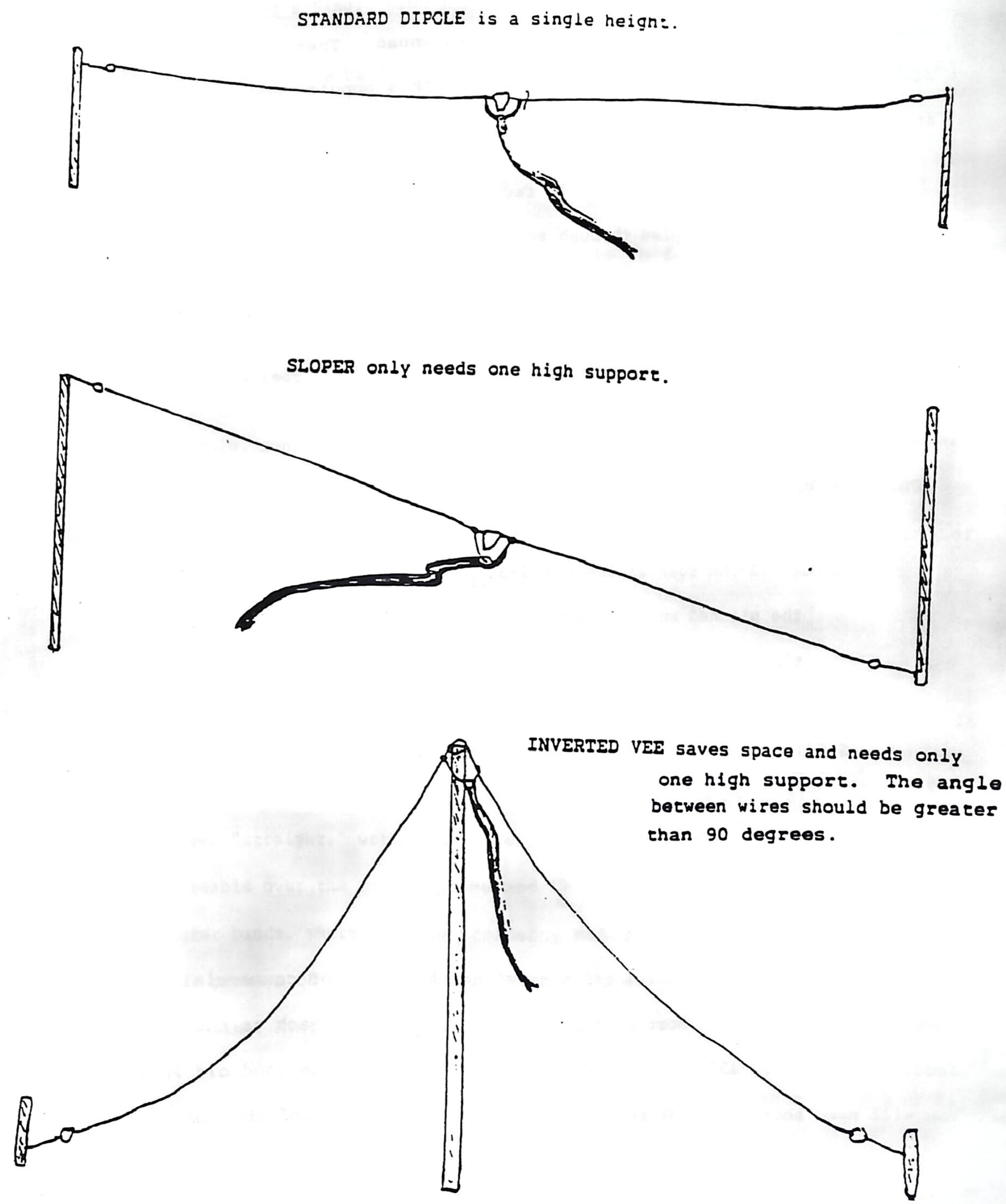


FIGURE 6-7: THREE DIPOLE CONFIGURATIONS

step-by-step procedure applies to all three antennas. There is one additional step for the inverted vee but, as I mentioned, this popular and effective antenna is quite worthwhile.

These antennas are single-band if fed directly; multi-band operation is possible if they are coupled through an antenna tuner. More on this later.

We will describe the assembly first, then discuss techniques for getting your creation as high as possible.

Bill of Materials for Dipole Construction

Quantity of wire (amount figured per step one, below)

Three end insulators (or two end insulators and one center connector)

Enough 72-ohm coaxial cable (RG-59 or equivalent) to run easily from the planned antenna center to your rig. Be sure to allow for slack, connector attachment, and errors!

PL-259 male coax connector with appropriate insert.

Sufficient nylon or other cord or rope to attach the antenna to the intended supports.

NOTE: If you plan to use a balun -- either homebrew or commercial -- the same things apply here. Most commercially-built baluns attach to the coax feedline with an SO-239 connector (the female version of the good old PL-259. You will need another PL-259 and electrical tape to waterproof the connection.

Assembling a Single-band Dipole

1. Cut wire for the band on which you plan to operate. Use the formula:

$$l = 468/f$$

where l = the length of the dipole in feet

f = the frequency of operation in MHz.

Add two feet to this length for wrapping around insulators.

For example, suppose we want to operate on the CW portion of the 40 meter band, but want to optimize the antenna for the whole band. We choose 7100 KHz, or 7.100 Mhz, as our design frequency. This is a little below the center of the band. Our wire length becomes:

$$l = 468/7.1 = 65.9 \text{ feet, or } 66 \text{ feet.}$$

Now add two feet for connections, and the total length of wire required is 68 feet.

When used "straight," without a tuner, dipoles cut for the center of a band are useable over the entire phone and CW band. The exceptions are the 80 and 160 meter bands, where the low frequency makes the band width a substantial portion of the frequency. With a tuner you can always work the whole band (hint, hint).

2. Double the wire and cut it exactly in two. Coil up each half and tape it, leaving a couple of feet at each end.

3. You need three insulators, or two insulators and a center connector (these can be gotten commercially or are easily constructed). Connect them as shown in Figure 6-8, being careful to leave a few inches at the center.

4. Prepare the antenna end of the coax as described earlier in this chapter.

5. Solder the coax end to the center of the dipole as shown in the figure.

IMPORTANT: IF YOU PLAN TO LET THE DIPOLE SLOPE, SOLDER THE CENTER CONDUCTOR OF THE COAX TO THE SIDE OF THE DIPOLE THAT WILL BE HIGHEST.

6. Attach (coiled) support cord to each end insulator, and you are ready to go! The completed dipole, is ready to be carried out and installed.

FOR THE INVERTED VEE DIPOLE ONLY

Center Support

A major advantage of the inverted vee is that only one high support is required. End support ropes are very short since the ends need only be a few feet off the ground. Attachment of the center support rope is shown in Figure 6-9.

Center Angle

The angle the inverted vee wires make with each other is not critical, but it should be greater than 90 degrees to prevent cancellation.

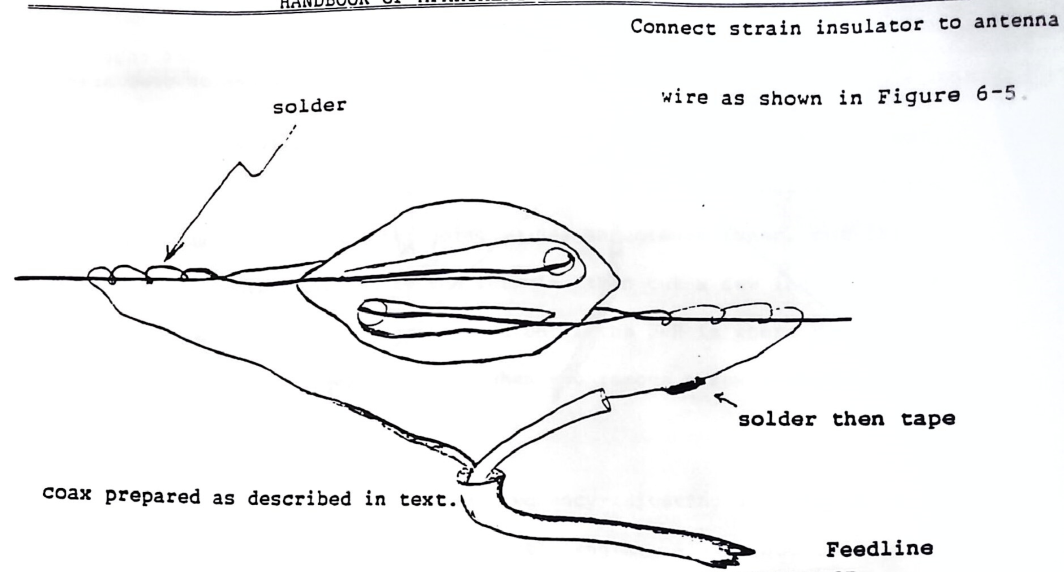


FIGURE 6-7 DIPOLE CENTER CONNECTION WITH STRAIN INSULATOR

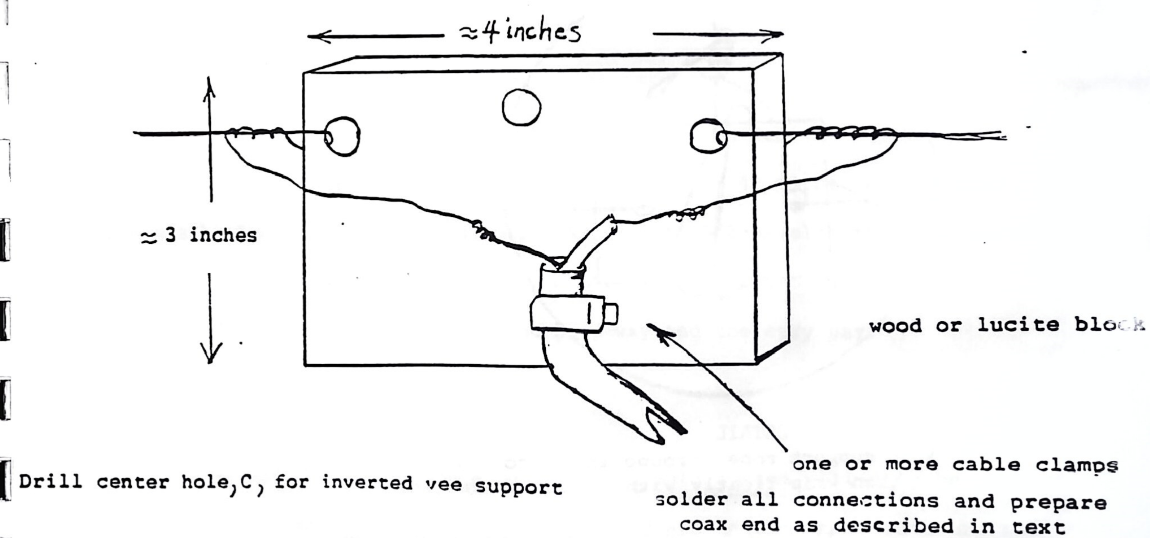
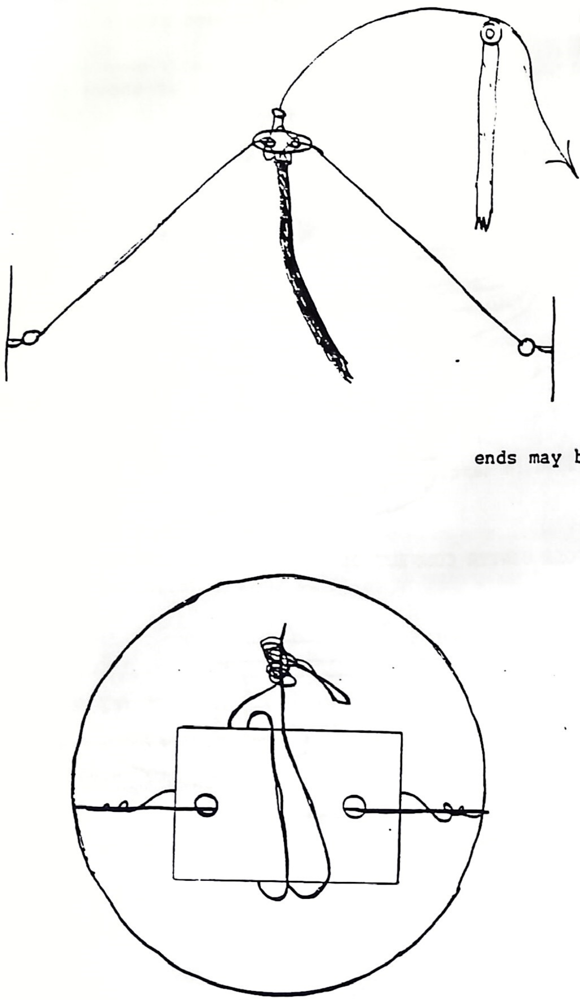


FIGURE 6-8: DIPOLE CENTER CONNECTIONS



DETAIL
wind support rope around insulator several times
then wrap tightly with electronics tape.

FIGURE 6-9: INVERTED VEE CENTER SUPPORTS

Length

The inverted vee will be electrically long for the frequency if it's cut by the standard formula given above. This is because of the proximity of the ends to the ground. If you are not going to use an antenna tuner, cut this antenna for the length indicated by the formula, then cut a few inches off of both ends and measure the SWR. Repeat this until the SWR is where you want it. If, by some chance, the SWR goes up when you remove a few inches, the antenna is too short -- start adding wire!

The important thing to remember when frequency-adjusting any dipole is that both sides of the dipole must be of equal length. Always add or remove exactly the same amount of wire from each side.

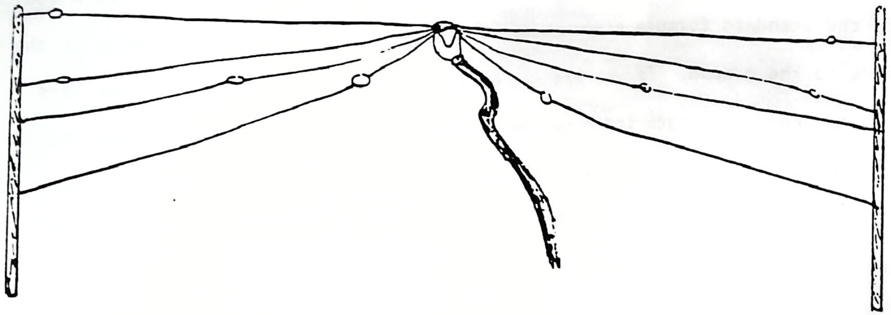
CONSTRUCTING MULTI-BAND DIPOLES

The dipoles just described are single-band when fed directly. The only exception is a dipole cut for the 40 meter band (7 Mhz). Since a half-wave antenna will also be resonant at 3/2-wavelength, a 40-meter dipole will also work on 15 meters (21 Mhz). There are two ways to go multi-band with coax-fed dipoles: the hard way and the easy way.

THE HARD WAY

This method of constructing a multi-band dipole system will only be briefly summarized, since it has been done to death in the standard books and magazines, and also because I don't see why you should trouble yourself. But that's up to you!

An antenna operated far from its resonant frequency (without a tuner) will not absorb power. The load appears as a very high resistance. Multiple



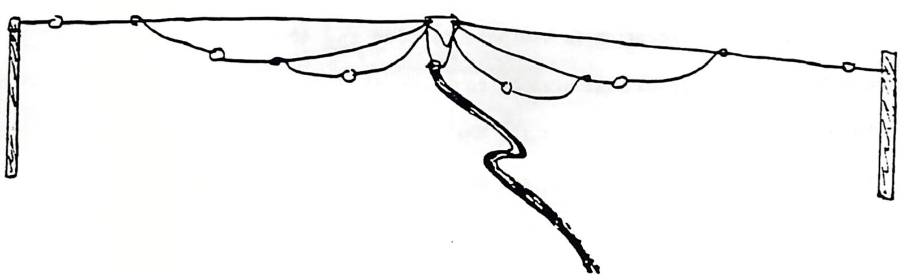


FIGURE 6-10: MULTIPLE DIPOLES

dipoles fed from the same coaxial feedline take advantage of this. Dipoles for each band are simply connected to a common feedline and either separately attached to supports or "drooped " together, as shown in Figure 6-10.

The dipoles should be separated by at least several inches to prevent interaction. If yours are connected in a "drooped" fashion, it is a good idea to tape small weights, such as fishing sinkers, to the bottom of each. This will prevent the wires from tangling in all but the highest winds.

THE EASY WAY

The more astute reader is probably wondering why, instead of stringing all those dipoles, we don't simply build one long dipole, feed it with coax, and tune it for all bands with an antenna tuner -- as with the random wire antennas.

Why, indeed?

I'm not sure. As far as I can tell this traditionally has been avoided for two reasons: First, versatile antenna tuners and transmatches have not always been readily available commercially, and parts have been hard to get for homebrew. Second, coax is lossy; that is, a less-than-ideal SWR will cause some energy to be absorbed by the line itself. This is probably why the multi-band antenna projects you see in the publications are generally fed with open-wire feeders (sometimes called tuned feeders).

Today's antenna tuners -- both commercial and homebrew -- will match about anything. Most have specific connections and circuitry for coax-to-coax operation, which answers the first objection.

The second objection, line loss, has some validity. But if your transmission line can be kept to fifty feet or less, the tradeoff is worthwhile. With longer feedlines it's a good idea to use RG-8 or RG-11 coax and take advantage of its superior loss characteristics.

As with our random wire antennas, almost any dipole length can be made to work on all bands -- with a good tuner. However, if you have the space the best bet is to cut the antenna for the lowest band you plan to operate on -- usually 80 meters. Space is saved by using the sloping or inverted-vee configuration.

I suggest you construct your multiband dipole as long as practical for your location. If you have the room, an excellent length for multiband operation is 77 feet per leg. This provides close to odd quarter-wave multiples on 20, 15, and 10 meters (5/2, 7/2, and 9/2 wavelength), and is an approximation for 40 and 80. It has not been tested on the WARC bands yet, but with a good tuner you can successfully load almost any antenna on any frequency. And if you can load it, it will radiate RF!

ERECTING OUTDOOR WIRE ANTENNAS

HOW DID YOU GET IT UP SO HIGH?

As with constructing multiband antennas, there is a hard way and an easy way to get your skywire aloft. The hard way is to climb whatever structure you intend to attach the wire to -- trees, rooftops, whatever. Often this is difficult -- even dangerous, and you wind up not putting your antenna as high as it could be. Make no mistake about it: At the relatively low heights of most apartment and condo skywires, every foot counts.

The easy way is to toss a light cord over the tree or other structure, follow it with heavy cord, then with the antenna support itself. Use the light line first; it's much easier to get height with modest weights.

Some hams have a favorite throwing stone. I have never had much luck with stones -- they have a habit of falling off of the end of the cord. Maybe I never learned the right knot! I use a piece of scrap metal that can be securely tied.

A method for getting wires to the top of tall trees that I've used quite successfully is the spincasting rod. A very heavy weight should be used, much heavier than would seem practical. Experiment until you get the optimum "throw"; with a little practice and the right weight you should be able to get over a seventy-foot tree with ease.

Two other methods are said by their practicioners to produce dazzling results. I have no direct experience with either. The first is the bow-and-arrow method, which is self-explanatory. Second, some hams have been tying one end of fishing line to a sinker and then firing the line from a slingshot. Great heights are claimed with this method.

Use whatever method you like best, but be careful! Those stones, arrows, and metal projectiles can puncture windows, pets, and the neighbors' kids. That is not the way to make friends for ham radio!

WHEN THE WIND BLOWS....

With wire antennas are attached to trees we've got the wind to think about -- when it blows, the movement of the trees snaps even stout wires. A simple idea will keep your antenna up in the worst weather.

You need at least one old bicycle innertube. When attached between the antenna and support wire, this tough rubber gives with the strain, protecting your antenna even in the strongest wind. Cutting lengths from the tube makes a neat-looking antenna and is very strong. The results are terrific. If the tree stays up, so will your antenna.

VERTICAL ANTENNAS

In the sense that the term is commonly used, a vertical antenna is different from either a vertical dipole or a vertically-placed random wire.

The major differences between the vertical and other antennas are the length of the radiator, and the use of radials. A true vertical antenna, including the popular ground plane, has an element length of 1/4 wavelength, as opposed to the traditional half-wave or longer dipoles and wires. The impedance matching is done with radial wires, the electrical equivalent of the counterpoise discussed in Chapter Seven. To be complete, we must add that different types of verticals can be constructed with vertical elements longer than 1/4 wavelength. Figure 6-11 illustrates the difference between verticals and other antenna types.

Verticals have the advantage of fitting into a tiny horizontal space. Additionally, they exhibit a low angle of radiation and are excellent for DX operation. Vertical performance depends on the number of radials that are used, how elaborate the ground system is (deep ground rods, etc.), and the conductivity of the soil.

A disadvantage of vertically-polarized antennas is its noise susceptibility. Most man-made noise is also vertically polarized. If you are

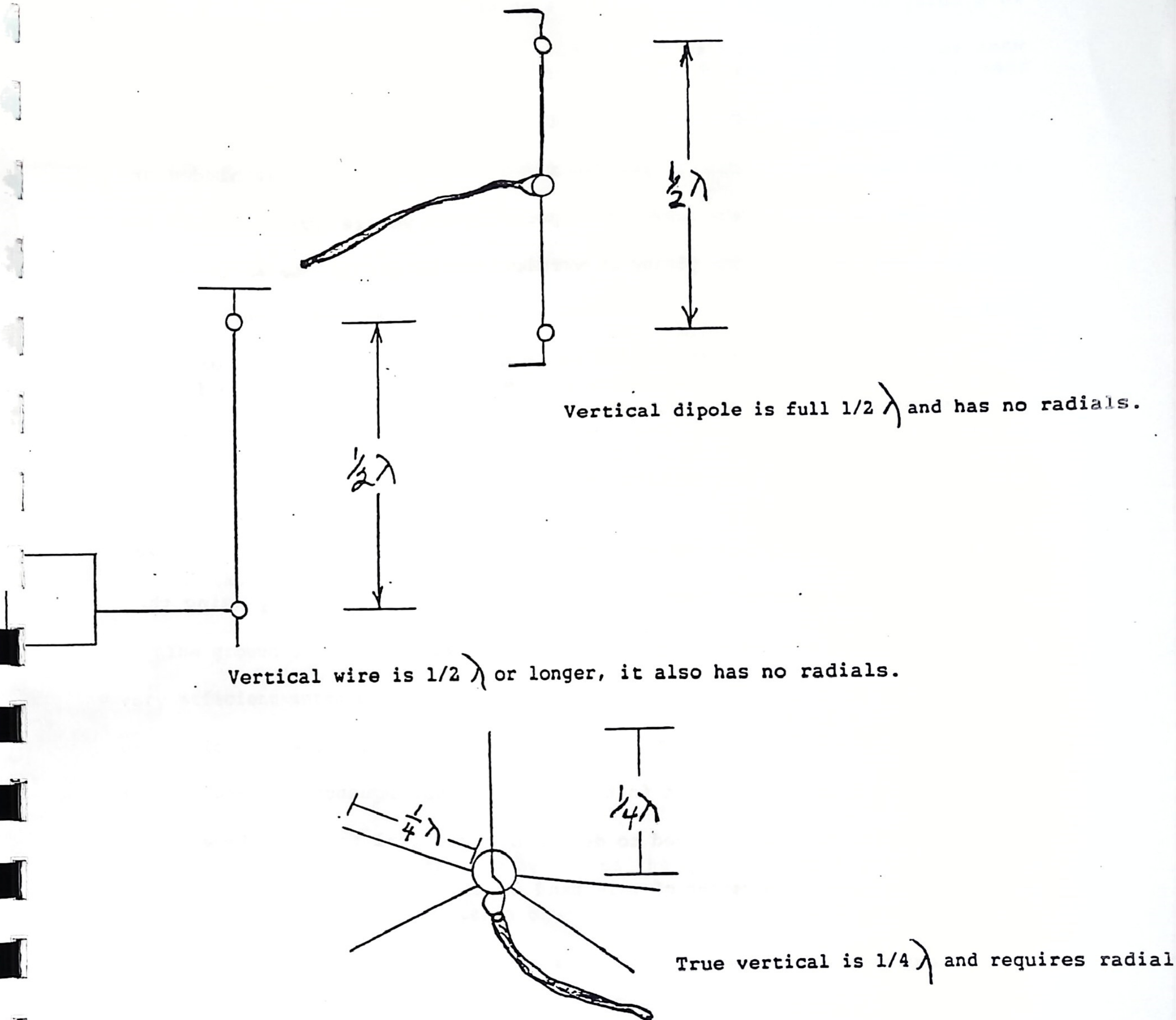


FIGURE 6-11: VERTICAL ANTENNAS

in a noisy QTH, such as a factory district or near a power substation, you may want to consider some other antenna type.

There are as many, or more, commercial and homebrew vertical variations as there are dipole deviations! If you can swing an outdoor antenna, hidden or not, a vertical could be the answer -- especially if you're stuck with a postage-stamp back yard with plenty of vertical space and little on the horizontal side.

A thorough discussion of the dozens of ham verticals in existence is beyond the scope of this book. But simple verticals and ground planes are easy to build and often easy to hide, so we'll talk about them now.

As Figure 11 shows, both the main element and the radials are cut to 1/4 wavelength at the operating frequency. This length is obtained by using the formula

$$L = 234/F$$

Where L is the length in feet, and F is the frequency in MHz.

For example, suppose we wanted to design our vertical for the 15-meter general phone band. The center of this band is 21.4 MHz. We then have

$$L = 234/F$$

$$L = 234/21.4$$

L = 10.9 feet or 10 feet, 11 inches.

Now we must decide whether our antenna will be a true vertical or a so-called ground plane.

THE TRUE VERTICAL

To qualify as a true vertical, an antenna must be mounted at or very near ground level. The radials are either buried a few inches down, or laid on the surface of the ground. If your situation lends itself, a convenient flower bed can be just the hiding place for radials. Now, the textbooks say you should have at least four radials, and the more the merrier. However, I've had good results with as little as one radial. The ground pipe usually isn't enough to provide a good match. Using an antenna tuner and loading the whole thing as a continuous system is not efficient with the vertical antenna, since the feedline usually must run along the ground. If it radiates, this energy is absorbed.

THE GROUND PLANE VERTICAL

The ground plane is a vertical that does <u>not</u> rest on the ground! It is a very efficient antenna and, like the true vertical, it is a good DX antenna with a low angle of radiation. Many Europeans sign "ANT HR IS GP, OM" while my S-meter is wrapped around its pin.

The ground plane gets its name by taking the ground with it; that is, the radials are grounded and act like a counterpoise, or artifical ground. The vertical, active element of the antenna "sees" a ground plane and radiates low-angle RF.

VERTICAL ANTENNA CONSTRUCTION

In terms of actual construction, the true vertical and the ground plane are treated pretty much the same -- the location of the antenna is what is different. General antenna construction details are the same as those discussed in previous chapters.

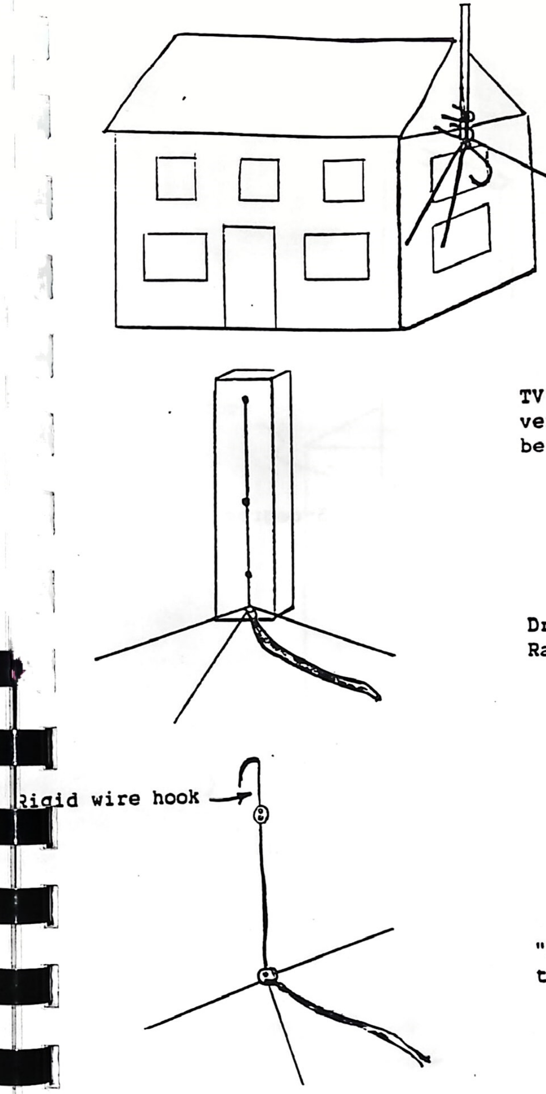
Vertical antennas may be single- or multi-band. Let's look at a good all-around design for each.

A Single-Band Vertical or Ground Plane

The vertical element of this antenna may be either aluminum tubing or wire. If you use tubing the diameter is not critical, and it doesn't have to be round. It is cut to length using the formula above, and is supported as shown in Figure 6-12. If the supporting structure is made of dry wood, extra insulation isn't necessary. You can use the skyhook version to hide the antenna in a tree. This version also makes an excellent portable antenna.

If the antenna is to be used as a ground plane, mount is as high as you can -- the radials can be used as guy wires but, in any case, be sure to include the insulators, as shown. The radials should slope about 45 degrees down from the horizontal because they act as an impedance transformer and the SWR of the antenna depends on the angle. Figure 6-12 shows the most common configuration. Operated as a ground plane, the radials can be disguised in a variety of ways. If your vertical is going to be placed on the ground, you can bury the radials by spading slits a few inches deep in a line away from the antenna, one line for each radial, and then tamping the radials into the slits.

Make the coax connection with care, using the techniques described in the construction chapters. Details are shown in Figures 6-13 and 6-14.

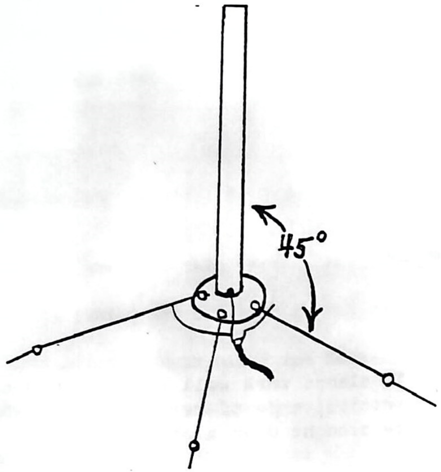


TV clamps work well for "in the open" vertical made of metal tubing. Radials can be brought down alongside.

Dry wood with attached wire is less visible. Radials are attached at base.

"Skyhook" vertical wire can be hidden in trees; radials are draped over branches.

FIGURE 6-12: THREE GROUND PLANE VERTICAL ARRANGEMENTS



A ground-plane should have at least three radials, all making a 45-degree angle with the vertical.

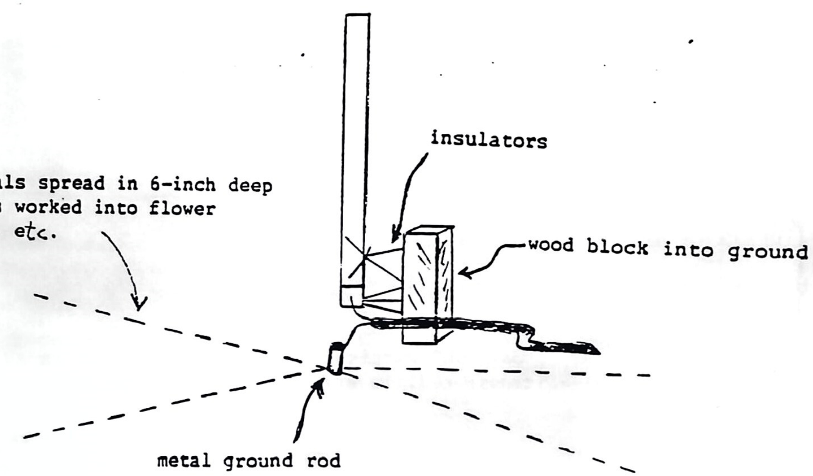


FIGURE 6-13: RADIAL CONNECTION FOR VERTICALS

HANDBOOK OF APARTMENT OPERATION

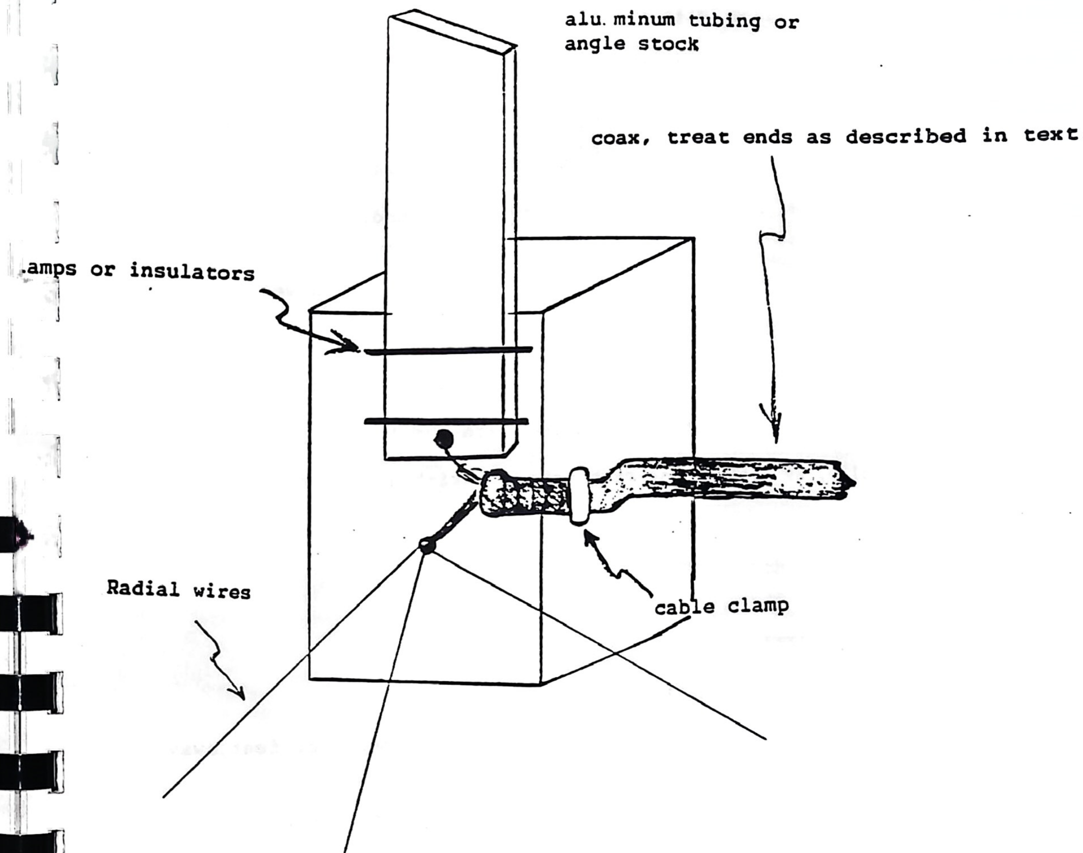


FIGURE 6-14: COAX CONNECTIONS FOR VERTICALS

A Multiband Vertical or Ground Plane

Multiband verticals are constructed using the same principles as multiband dipoles. For the ground plane, with its coax feed line in the clear, an antenna tuner is used for all-band operation. As with dipoles, the feedline radiates. Another approach involves using multiple wires. This is shown in Figure 6-15 for the ground plane antenna. If you build this antenna use above-ground radials, even if the antenna is near the ground.

The verticals just described are proven designs and will work well. Using your trusty antenna tuner and a little imagination you can experiment and come up with exactly the right the combination for your apartment or condo. If a vertical is right for you, you might also investigate the trap-style verticals available commercially, as well as the many other multi-band ideas available in the literature.

INVISIBLE OUTDOOR ANTENNAS

An invisible antenna is usually made of thin wire. It looks like an antenna but cannot be seen from more than a couple of feet away.

Invisible antennas are nearly always the random wire type. This gives them a versatility that dipoles just don't have. In addition, two of the dipole brothers discussed earlier -- the standard dipole and the sloper -- are strained at the center with the weight of the coax feedline. This is okay for standard outdoor wire sizes, but the thin stuff you must use for invisible antennas stretches immediately and snaps in the first stiff breeze.

All the principles of the random wire (or dipole, if you must) we've covered before apply here. The differences lie in two areas: construction practices, and placement and erection schemes. We'll take them one at a time.

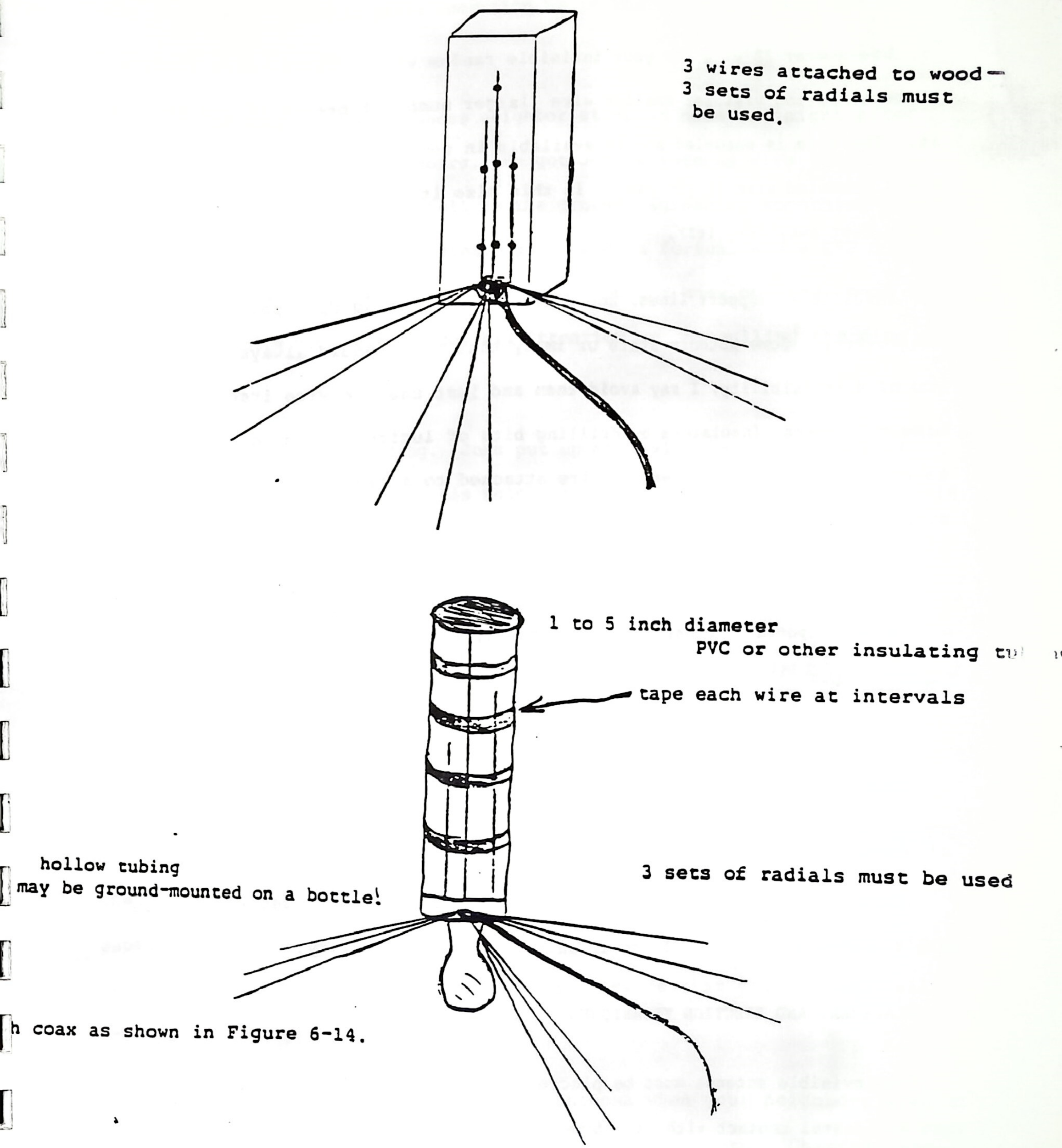


FIGURE 6-15: MULTIBAND VERTICAL CONSTRUCTION

CONSTRUCTION PRACTICES

Use number 28 wire for your invisible random wire. Larger wire (smaller numbers) is too visible; smaller wire (larger numbers) breaks if you stare at it. The wire is enameled and is available in several colors. Get blue or brown enameled wire if you can -- in this size it is invisible from more than a few feet away (try it!).

Insulators, support lines, and other hardware bring up a point of controversy. Some authors state or imply that they should always be used. If you need invisibility, I say avoid them and just use the wire itself. You can make teeny-weeny insulators by drilling bits of lucite. I've never been able to tell the difference between a wire attached to a tree or other non-metal support when insulators have been used, and when they have not.

If it is important that your wire be undetected, by all means run it to non-metal supports -- other buildings, trees, etc., and forget insulators and support ropes.

RULE OF THUMB: SOME ANTENNAS ARE BETTER THAN OTHERS. ANY ANTENNA IS BETTER THAN BEING OFF THE AIR.

Believe it. And read Chapter Eleven on landlords and leases before you make an antenna decision. It could save you a lot of misery.

PLACEMENT AND ERECTION TECHNIQUES

The invisible antenna must be placed where people and pets can never come into accidental contact with it. Some hams hook up an outside wire at night,

then retreive it either it after operating or in the morning. Even this method can have problems.

I know personally of a ham whose neighbor stumbled home one night after practicing his hobby for a few hours. He got John's antenna wire tangled around his neck and immediately fell to the ground, screaming something about a UFO attack. A small crowd gathered. John, who is fortunately a QRP nut, went right on operating. He had the headphones on and knew nothing about the excitement outside until his XYL got his attention -- by pulling the plug on his rig.

The story has a happy ending. John put up an invisible skywire out of reach of children and tipplers. His neighbor got religion, sobered up, and is an example to all who know him.

There is a form of Murphy's Law in operation here:

IF THERE IS ANY WAY FOR ANY CREATURE TO TRIP OVER AN INVISIBLE ANTENNA, IT WILL.

So put your invisible wire where nobody and nothing can get tangled in it.

The main thing to watch out for when installing your invisible antenna is the strain on that thin wire. Never pull the wire taut and then tie it, especially when the support will move in the wind. Sag -- even quite a bit of it -- won't affect the radiation much and will assure that your antenna will stay up.

You will want to put up your invisible antenna when your neighbors aren't around. Fine, but don't forget the kids -- theirs and yours. Children are

curious and have notoriously big mouths. However, they are extremely gullible. If they do catch you in the act, a cock-and-bull story will usually satisfy them. Tell them you're building a net to catch Martians -- then laugh fiendishly. They'll get the point. And by the time anybody can question you, your invisible wire will be in the air, out of sight.

As with any antenna, never run your invisible wire near power lines.

DISGUISED OUTDOOR ANTENNAS

An invisible antenna looks like an antenna, but it can't be seen. A disguised antenna, on the other hand, is right out there in plain sight -- except that it doesn't look a bit like an antenna -- a ham antenna, that is.

In theory, any structure that can be loaded up (be made to accept RF power) must radiate. This means that anything metal is fair game! Here is what our selection criteria for an outdoor disguised antenna should be:

- Made of metal
- Not grounded (a grounded object can be loaded. But that's beyond the scope of this book!)
- Reasonably safe from accidental contact with people and pets while radiating.

As you can see, your imagination is the only real limit. I'll talk about a few of the most popular schemes, but you will be able to think of more. Remember that any antenna (these included) can be fed with a single wire instead of coax and tuned with an antenna tuner. When this is done the entire system -- antenna, feedline, and all -- acts like one piece of conductor and radiates. A bit of experimentation will help you decide your preference.

If your operation is under cover, I advise you in any case to use an antenna tuner and to work all bands with a single antenna, rather than trying to put up separate antennas.

THE PATRIOT'S ANTENNA (OR, FLAGPOLES HAVE MANY USES)

A small flagpole can be placed out the window of many apartments. This disguise provides some excellent possibilities, a few of which are shown in Figure 6-16.

Combining the angled flagpole with an indoor wire is an excellent way to create a more efficient antenna. You can even hang a flag from it!

TV, YES ... HAM RADIO, NO!

Many apartment buildings and condos have strict rules about antennas -- except television antennas! If you can get permission to erect a TV antenna by all means do so ... the biggest one you can swing. Or use an existing antenna and reroute the twinlead feedline into your apartment, if necessary. Twist the two ends of the twinlead together and attach them to the random wire output connector on your antenna tuner. You now have a dandy combination antenna: the twinlead, shorted at the tuner end, acts like a good random wire, and the TV antenna gives it radiating area that is high and in the clear.

Check the path of the TV twinlead before doing this in any modern apartment complex. In some buildings long runs of twinlead are threaded through the metal building frame, or through conduit. This is bad for the TV picture, and worse for you -- much of your precious RF is absorbed.

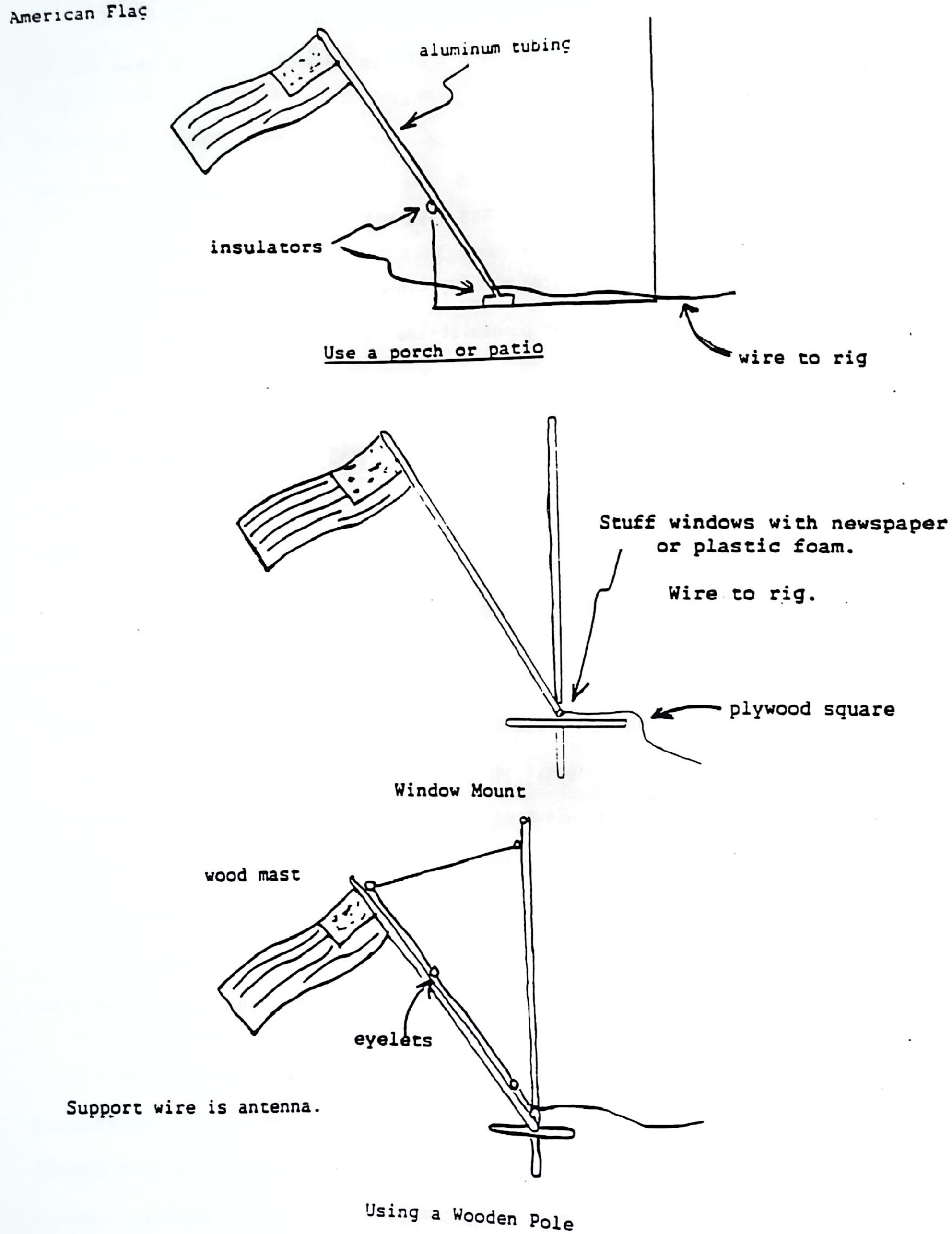


FIGURE 6-16: FLAGPOLES IN THE WINDOW

An approach that may give good results on the higher bands (20, 15, and 10 meters) is balanced-line feed. The 300-ohm TV twinlead is connected, as is, to the <u>balanced</u>-line output of your antenna tuner. Now the feedline still radiates, since the TV antenna is grossly mismatched, but the system behaves more like a too-short antenna. I would try this as an alternate to tying the feedline together -- experiment and see which is best. I've never done it as a balanced-line feed myself, and the reports from other hams that I have on its performance are ambiguous. I mention it here only because it may be worth a try.

<u>WARNING!!</u>

THIS DISCUSSION APPLIES <u>ONLY</u> TO SINGLE-FEEDLINE TELEVISION ANTENNAS. DON'T TRY IT IF THE ANTENNA SERVES MORE THAN ONE SET. (BOY, WILL YOU BE IN TROUBLE!!)

THE USEFUL CLOTHESLINE

Today, many apartments do not allow wash to be hung outside. But for those who do, what could be more natural than a clothesline -- terminating at or near your window, porch, or balcony, of course! Make it with regular clothesline and wind dullcolored enamel wire around it in a helical fashion, as shown in Figure 6-17.

A few strategically placed clothespins add an authentic effect.

Some older apartments in my area have built-in monsters that look like upside-down pyramids (Figure 6-18). There are many weird possibilities if you have one of these! You could try loading the whole thing -- as with other "mass-of-metal" antennas. Use an alligator clip and experiment with load

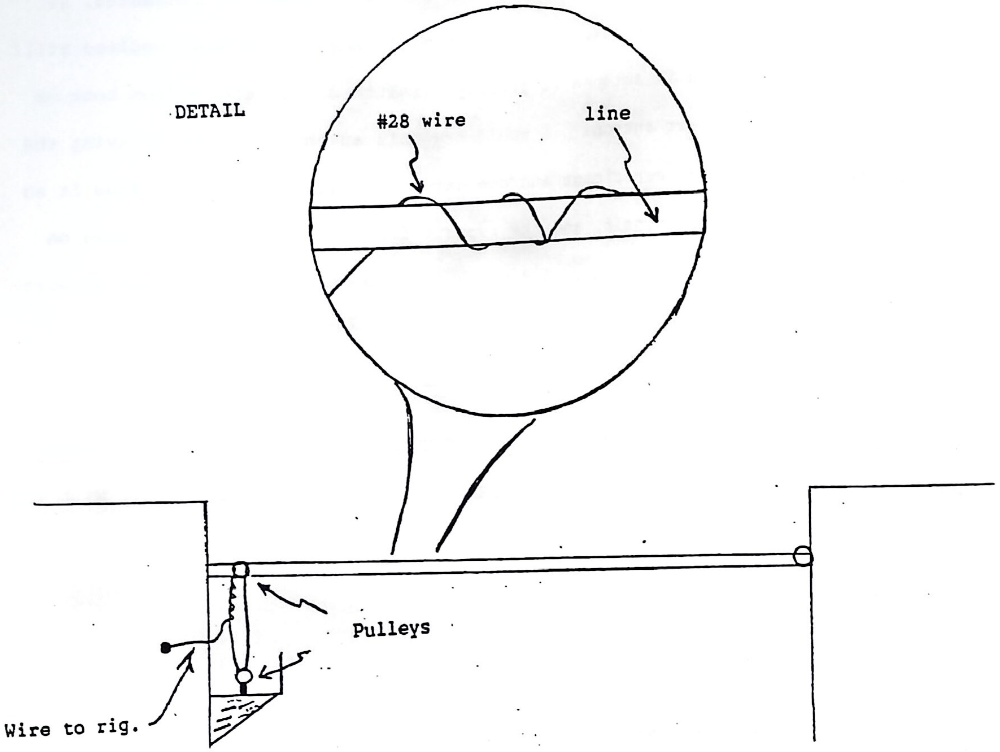


FIGURE 6-17: THE CLOTHESLINE ANTENNA

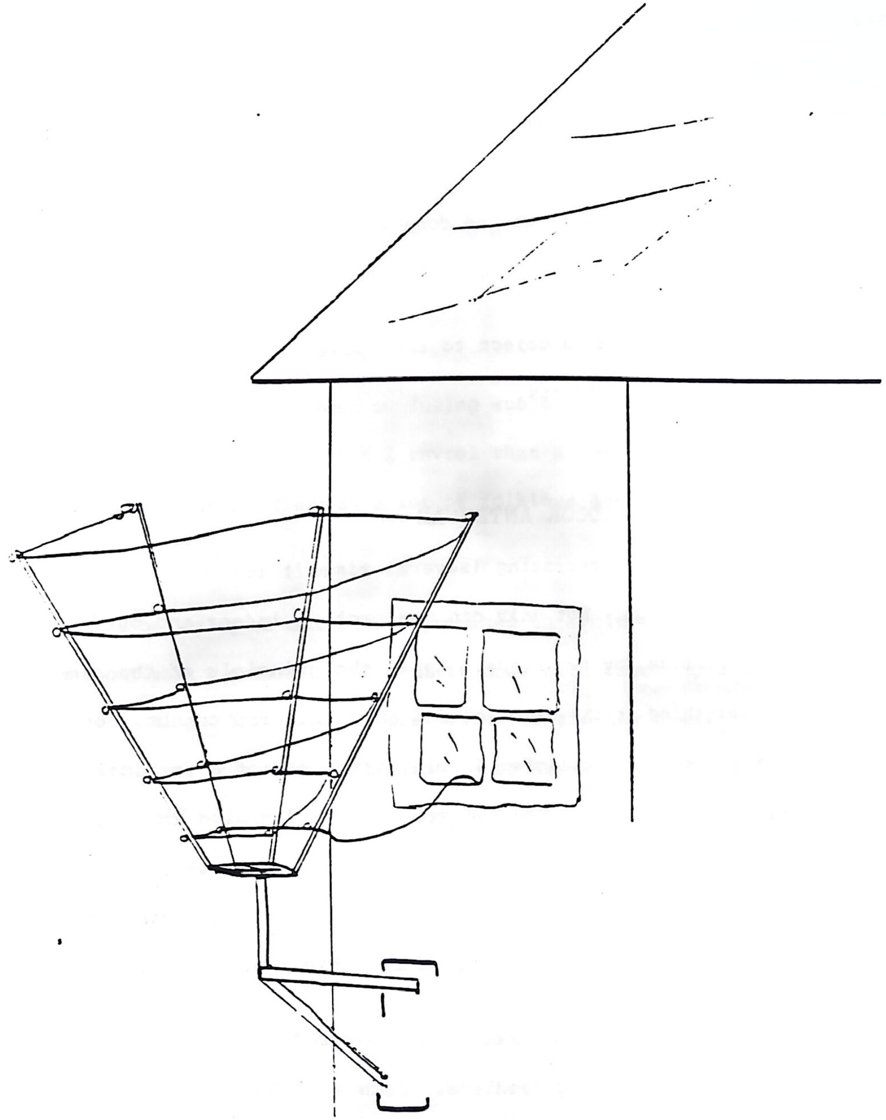


FIGURE 6-18: OUTDOOR CLOTHES HANGER ANTENNA

points. Another approach is to wind it with insulated wire, insulate it from the metal frame, and put what results on the air. You never know what works until you try, since every location is different. And experimenting is great fun!

These examples represent what can be done with disguised antennas. Survey your own situation and see what will work for you.

Remember: If you can get an object to take power ("load up") it will radiate, and you will make contacts.

COMBINING INDOOR AND OUTDOOR ANTENNAS

A rule of thumb worth repeating (several times!) is:

Get it long and get it high. Not only can you combine indoor and outdoor antennas, you can combine any two kinds. Apply the principle of the random wire, and feed everything as the same end-fed antenna. You cannot, for example, connect the end of a coax-fed dipole to the top of a vertical and expect a better performance. But you can extend a random wire through the attic or crawl space, then outside -- perhaps the outside portion would be invisible. The window flagpole type disguised antenna just discussed might be combined with an indoor wire -- all connected as a big random wire.

Remember, though, a danger we talked about in our discussion of vertical antennas: antennas with radiating feedlines, such as random wires and dipoles operated out of resonance, must have the feedlines kept away from the ground and from RF-absorbing objects. As long as this is kept in mind, you can experiment to your heart's content.

CHAPTER SEVEN: GROUNDING YOUR RIG

At some point, most articles that talk about antennas mention the necessity for a "good earth ground." How do you get such a ground -- not only when the rig is at or near ground level, but also when it is several stories up in the air?

Grounds are one of the most confusing subjects a newcomer faces. And I'm not telling any big secrets when I reveal that a few old timers have a bit of trouble in this area. There is a lot of folklore around, both on the air and off.

At the beginning of this book I promised to avoid theory -- but! A few words about what a ground is and what it does will clear up a lot of misunderstanding. The following discussion is greatly oversimplified; some would say naive. But this isn't meant to be exhaustive or precise (rigorous is the textbook term). I want you to get a feel for what goes on electrically, and to know why a good RF ground does not have to be grounded.

WHY A GROUND?

As Figure 7-1 shows, without a ground your rig is at one end of an RF-generating system. As energy leaves your transmitter and antenna tuner and enters the antenna or transmission line in an unbalanced (one-sided) antenna system, the RF voltage at this point on the line may be quite high, depending on the length of the line/antenna system and the frequency of operation. Thus, an antenna system that behaves as though it were ungrounded at some frequencies (high RF voltage in the shack) may "look" grounded at others.

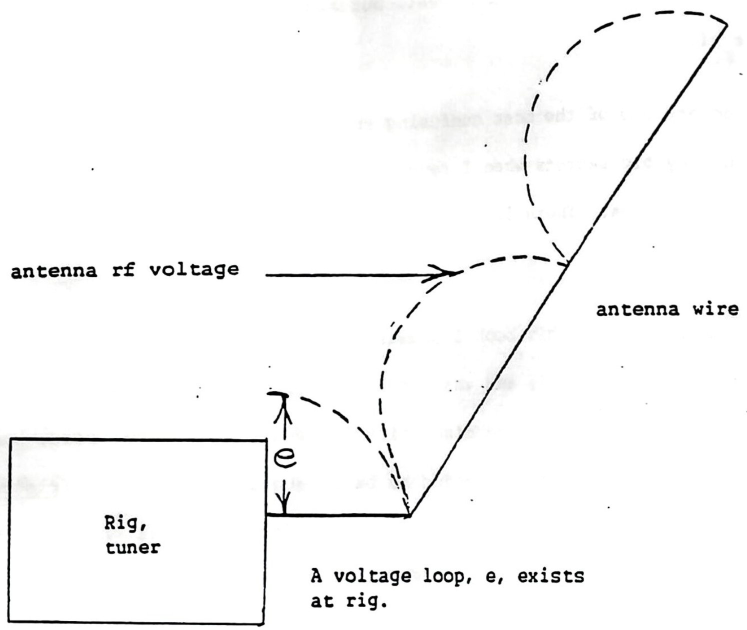


FIGURE 7-1: UNGROUNDED RIG

In theory, careful measurement can make the system "look" grounded on all the desired operating frequencies with no ground system at all. In practice, you can forget it. You have to install a ground system!

RF IN THE SHACK

Several conditions can exist when an rf-generating system is not grounded.

Condition 1: "Hot" chassis. Remember, an ungrounded transmitter produces a lot of RF voltage at the rig end of your transmission line. This is very important! A major symptom of poor grounding is the hot chassis -- better known as the "Ouch, the sucker bit me!" syndrome. This is what happens: the high RF potential at your rig "sits" on the metal chassis. It can give you anything from an annoying nip to an extremely dangerous RF burn, so BE CAREFUL!

DON'T INVITE RF BURNS.

Condition 2: The RF output and transmitter plate current change when your hand approaches a chassis. This is an excellent indication that your system ground isn't what it should be. Because the chassis is at a high Rf potential, the proximity of an object at a lower potential, like your hand, creates a change in capacitance. This capacitance varies with the distance between your hand and the chassis.

Thus, you are changing the capacitance of your output circuit, much the same as when you vary the tuning and loading capacitors in the final tank circuit. This change is shown by plate current and Rf output changes.

Sometimes other factors, such as parasitic oscillations, can cause such changes. And be sure you aren't bumping a loose connection with your hand or arm, as happened to me.

Condition 3: Talkback. When talkback occurs you can hear your transmitter output -- a thumping sound on CW, garbled voice on SSB -- in your speaker or headphones while transmitting. (If you start to hear this on receive, see a doctor.)

Also, electronic keyers may bleep and neon bulbs light. What's happening is that the RF sitting on your rig's chassis is getting rectified in these devices and triggering them. Note, however, that some solid-state devices are particularly susceptible to RF pickup, even with good grounding. The worst offenders by far are the audio filters, followed by electronic keyers. When you make your tests it's a good idea to take these devices out of the circuit. Some are quite good when properly installed; others are hopeless.

If you have a faulty ground system you will probably experience a combination of the three conditions. Again, if you suspect that RF is present on a chassis -- don't touch it! Correct the situation first.

GROUNDS THAT AREN'T

We've talked about why a ground is necessary, and how our rig will behave when it isn't grounded.

So how do we ground the darned thing from an apartment?

Take another look at Figure 7-1. Our problem, as it shows, it the high impedance (and resulting high RF potential) resulting from putting the

transmitter at one end of an unbalanced antenna -- where an RF voltage peak occurs.

Now let's examine a conventional ground, as shown in Figure 7-2. This is the one most articles assume you will have. This ground consists of a length of heavy wire connected from the rig ground bus to at least one six-foot metal rod driven into the earth. The connecting wire should be short compared to a quarter wavelength at the operating frequency. If it cannot be this short it must be cut to avoid quarter-wave multiples on the operating frequencies. The reason for all this will become apparent in a moment.

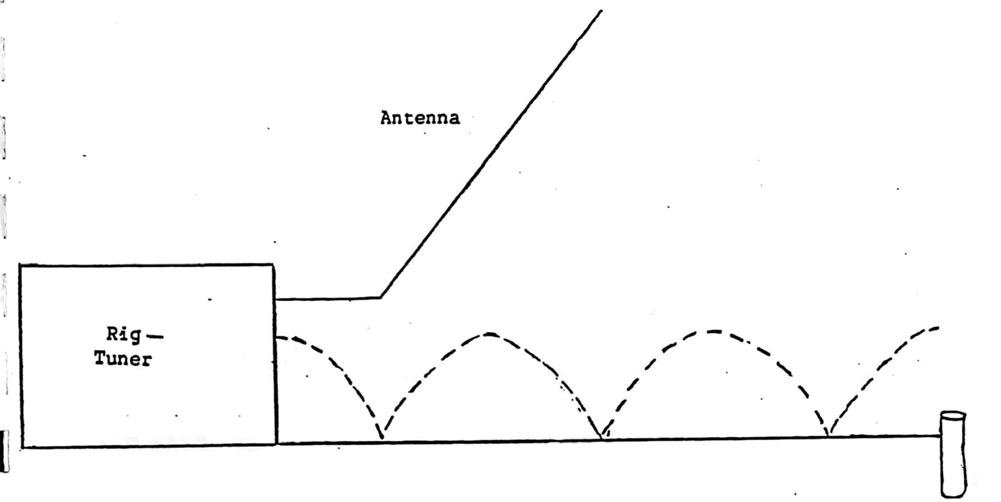
What this ground (or any other ground) does is electrically move your rig from one end of the antenna system to the middle. A high RF voltage point at the antenna end is balanced out by a low (inverted) point at the other end of the ground system. On the other hand, if the antenna end is at a low-voltage point, the reverse occurs and the result is the same (Figure 7-4).

The reason we avoid using multiples of a quarter wavlength for our ground wire is this: if the RF voltage is allowed to go through a quarter-wave multiple of its cycle, its effect is reversed (impedance inversion), putting you right back where you started, as shown in Figure 7-4.

So far, we have had a dandy explanation of what happens at actual ground level, where ground means earth and life is simple. But what about the OMs and YLs three or four stories up -- or at ground level where "ground" is an expanse of blacktop or concrete?

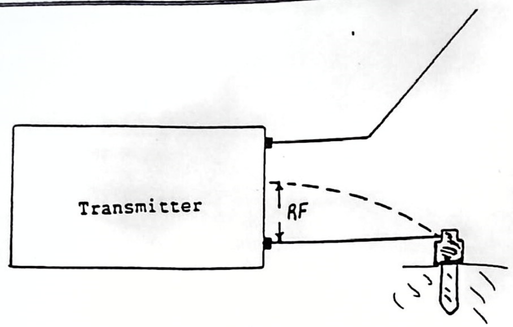
Rig at ground level. Short connection to 6' ground stake or buried radial system

FIGURE 7-2: TRADITIONAL EARTH GROUND



RF voltage is distributed along a ground wire,as with an antenna. A long ground wire may produce an RF loop at the transmitter.

FIGURE 7-3: VOLTAGE DISTRIBUTION ON A GROUND SYSTEM



A quarter-wave earth ground causes an RF voltage loop at the rig.

A slightly longer wire lowers the RF voltage

A 1/2-wave earth ground provides zero RF potential at the rig.

FIGURE 7-4: GROUND IMPEDANCE INVERSIONS

THINGS TO AVOID

Before we talk about how to do it right, it's important to clear up a few myths about grounds. At the risk of seeming negative (pun intentional) here's how NOT to ground your rig:

DON'T: Run a long piece of wire to ground level just to get an earth ground (you won't).

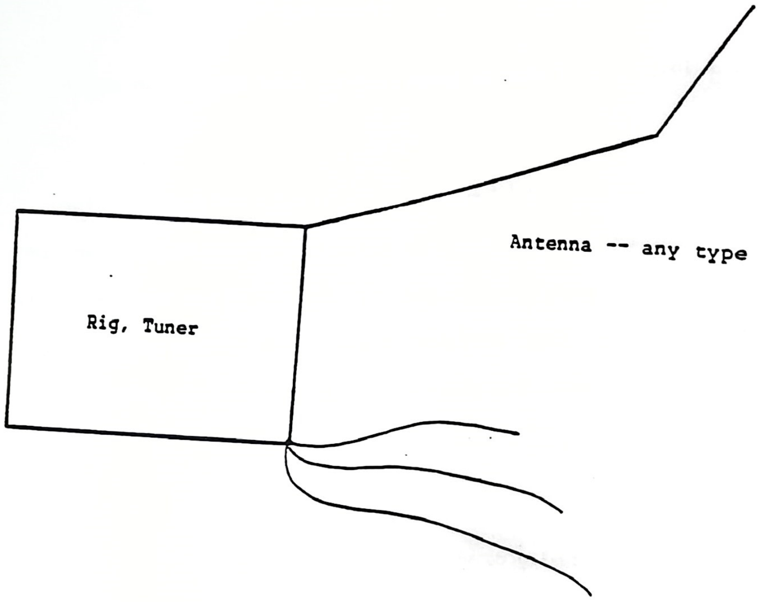
DON'T: Try to ground your rig by running a wire to a cold water pipe, heating duct, or other such system. There is often no way to know if any of these devices are actually earth grounded and, if they are, how much metal is between ground and your rig. Also, many modern apartment houses ground their cable TV lines to these systems. You could create a serious TVI problem!

AT LAST, THE CURE

Remember that what we really do when we ground a rig (RF ground) is place the rig electrically at a point of low impedance, and therefore at low RF potential. We showed how this was done with a conventional earth ground.

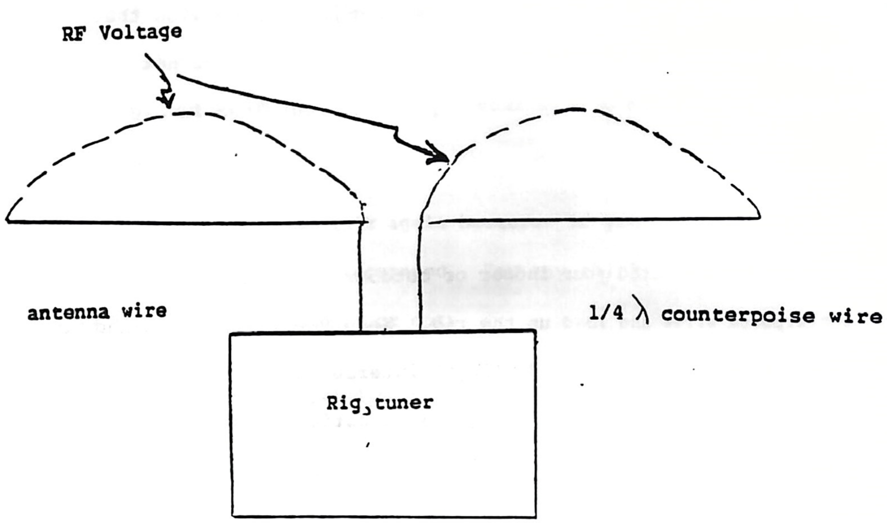
THE SAME THING CAN BE DONE WITH QUARTER-WAVE WIRES

To effectively ground your rig, cut a 1/4-wavelength wire for each band you plan to operate. Connect one end of each wire to the rig ground bus, and run the wires away from the rig, without tangling or doubling back. If possible, it's good to separate the wires by an inch or so with non-conductive spacers; then just lay them out as a unit. Of course, they can all be tacked or stapled in the same area, as long as there is at least a little spacing between them to avoid interaction.



Counterpoise wires: one-quarter wavelength each, one for each band. Connect to rig/tuner ground.

FIGURE 7-5: USE OF COUNTERPOISE WIRES



The transmitter is now at the electrical center of the system.

FIGURE 7-6: BALANCED VOLTAGES ALONG COUNTERPOISE SYSTEM

AS WITH ALL ANTENNA AND GROUND WIRES, KEEP THEM OUT OF REACH OF CHILDREN AND PETS

Old timers called a ground wire like this a counterpoise. They were probably thinking of the physical analogy to a counterweight that balances the force on one side of a mechanical system against the other, creating a neutral state in the middle. With a counterpoise wire, the phase inversion that occurs if this quarter-wave wire is grounded at the far end does not happen, and the rig is in the middle of a balanced system as indicated in Figure 7-6.

CHECKING IT OUT

After you have erected your indoor or outdoor antenna, set up counterpoise wires and load up the rig. Keep you tests short and in unoccupied parts of the band to avoid illegal interference. Look for signs of poor grounding on the various bands, using the conditions described at the beginning of this Chapter. You can be pretty sure your system is grounded and ready to go if none of the symptoms is present.

If poor-ground symptoms appear, first try disconnecting all counterpoise wires except the one for the band you're operating. If that works then add the other wires, one at a time, until the offending one is found. Try changing its length slightly. Also, check for pickup in other equipment, especially audio filters. Make sure your rig and tuner are adjusted properly.

A good test any time you want to see if the problem is in your antenna or ground system is to see what happens on the dummy load. If all is well with the dummy load connected you can be pretty sure you have an antenna or ground system problem.

CHAPTER EIGHT: DESPERATION MEASURES

I maintain that any ham, in any circumstance, can set up a station and make contacts.

That statment was made at the beginning of this book, and I'm making it again. It's a strong statement and I can back it up. Not only can you make contacts in any environment, you can have lots of FB QSOs and enjoy our matchless hobby.

I've replayed this pep talk again because, if you are reading this chapter, you are probably discouraged. You may think you have no room at all for an antenna, either indoors or out.

Take heart -- we are going to get you on the air!

WHAT IS AN ANTENNA, ANYWAY?

Let's examine some basics -- not from a theoretical standpoint, but with a very practical eye.

New hams hear a lot of fancy terms batted about, especially when the talk turns to antennas. One of these terms is radiation resistance. Now, the last time I looked at the questions on the Novice Exam, Ohm's Law was there. So was the concept that power is dissipated in a resistance. Most people readily understand this because it is easily visualized in familiar terms. The relationships are:

Voltage = Current X Resistance

and

Power = Voltage X Current

If we consider a circuit containing only a light bulb, for instance, it is easy to see that the ratio of voltage to current determines the electrical resistance of the device, and that the product of voltage and current determines the power consumed.

Further, we see that for every device some power is used to perform the intended task -- light a bulb -- while the rest of the power is wasted, usually in heat.

The point of this digression is to highlight several important facts:

FACT #1: Every antenna possesses a resistance, its <u>radiation resistance</u>. The RF energy that is radiated from an antenna appears to have been dissipated in this resistance. The energy that is not radiated is wasted as heat, just as in the light bulb.

FACT #2: For every antenna there is one frequency at which the radiation resistance is the only (theoretical) factor. This is the frequency of natural resonance and it is where the antenna operates at maximum efficiency.

FACT #3: Antennas may be used effectively at frequencies other than the natural-resonance frequency by employing matching devices. Operation at

frequencies other than this resonant frequency, with or without the use of matching devices, results in some losses.

FACT #4: As a consequence of the first three facts, <u>any object composed of a conducting substance may be used as an antenna</u>. If it is operated away from its natural-resonance frequency, some RF power is lost in heat. But the remaining RF <u>will</u> radiate.

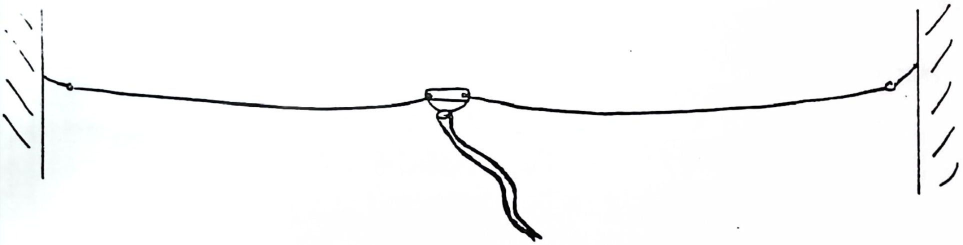
"Fine," you say, "but I'm desperate and you're spouting antenna theory!"

Well, not exactly. First, these facts are not theory. (The theory boys are probably ready to string me up, by now!) Second, understanding a few things that are often misunderstood helps you out of desperate situations.

To illustrate the point, let's look at two very different antennas for the 80-meter band. The first is a full-sized dipole, fed at the center with 50 feet of low-loss coax. The second is a three-foot whip with a massive loading coil and parallel-tuned capacitor at the base for impedance (resonance) matching. These antennas are shown in Figure 8-1.

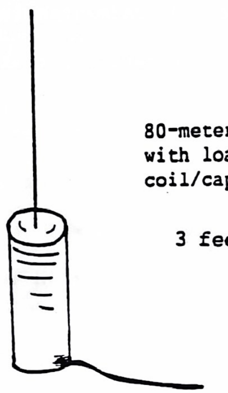
Many hams know intuitively that the big dipole outperforms the little whip, but they're not sure why. The reason is that the tiny whip has a natural resonance widely different from 80 meters -- and the big coil is needed to adjust the impedance to a level where the system accepts and radiates RF power. The price that is paid is high: most of the RF energy is dissipated in the coil and wasted.

We see, then, that in selecting our desperation antennas we can make a rough prediction how each will perform, and make our selections accordingly.



Full-size 80-meter dipole:

133 feet



80-meter whip
with loading
coil/capacitor:

3 feet!

Both antennas load up on 80-meters, but most of the RF energy entering the whip antenna is absorbed by the coil and wasted.

FIGURE 8-1: 80-METER ANTENNA COMPARISON

RULE OF THUMB: THE GREATER THE INDUCTANCE USED TO MATCH AN ANTENNA, THE LESS EFFICIENT THAT ANTENNA WILL BE.

This loss is not necessarily bad -- with our antenna tuner we trade off a bit of loss in the coil in favor of a simple, multi-band system. Also, some tuners are better than others because the coils are of higher quality. Air core coils are less lossy than iron-core types, and overall design affects the efficiency of all coils.

When we use a coil of any kind we lose a bit of RF. Consider trap antennas, for instance: verticals, beams, dipoles -- all traps contain coils, and all sacrifice <u>some</u> efficiency. It's a compromise, but not necessarily a bad one.

SELECTING, CONNECTING, AND TESTING AN ODD ANTENNA

Now we know something very important: Given a big enough coil and a small enough antenna (for the frequency), we could end up with a "system" that loaded beautifully, taking power smoothly with an indicated SWR of close to 1:1. And it would radiate practically nothing!

When selecting and trying out our odd antenna system, then, we must remember not to get carried away with loading coils. Not much wire or metal surface is needed to make a radiating antenna -- about eight feet is a minimum for 80 meters, and that's pushing it. But resonance should be achieved in a good tuner with a combination of capacitance and a high-quality inductor, not by adding more and more turns to a coil.

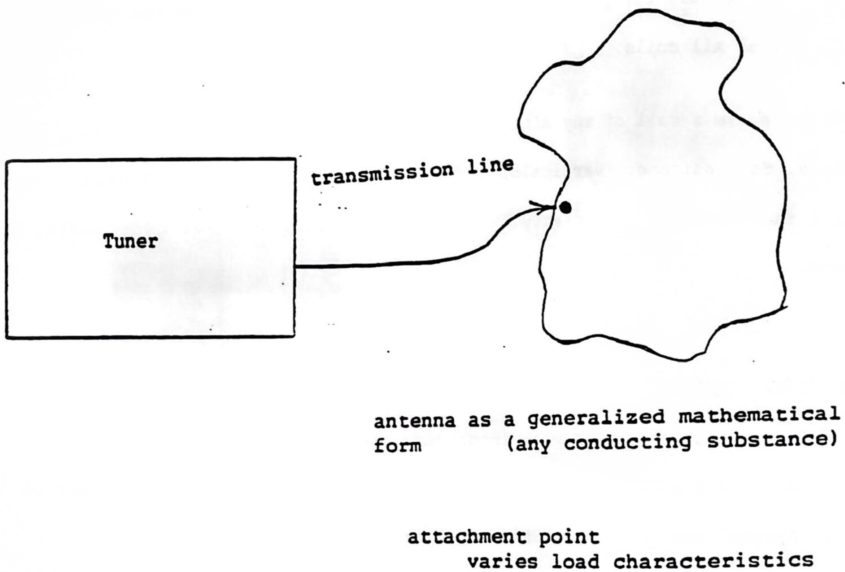


FIGURE 8-2: GENERALIZED ANTENNA

With that in mind, let's look at our prospective antenna. We're desperate, remember. A mathematically-general view of all possible indoor or outdoor antennas might look like Figure 8-2.

The blob in the drawing represents any conducting material.

RULE OF THUMB: EVERYBODY, EVERYWHERE, HAS <u>SOMETHING</u> THAT WILL WORK AS AN ANTENNA.

BED SPRINGS

How about your bed springs? Don't laugh! Two of my colleagues have used bed springs successfully: Bill, WA1NGA, stood the springs up in a corner of his walk-in closet. A second fellow, who must remain anonymous, simply attached his 'gator clip to the bed itself. It worked fine and he got out famously, except that he forgot to tell his XYL. He had the headphones on and was concentrating on a hot DX pileup. She decided to take a nap ... you guessed it. After he peeled her off the ceiling he had some fancy explaining to do. He's lucky he's not in a <u>singles</u> apartment after that experience!

DOWNSPOUTING AND DRAINS

Any spout or drainage system is worth a try. Drill a small hole in the metal spout and thread a screw through it. Then attach your feed wire to the screw and you're in business. A warning, though: Points where the spouting is welded or bolted together sometimes make a resistive connection that rectifies RF. This produces tremendous RF interference. So, if you try using your spouting, listen to your own radio and tv and see if your signal is still clean in the neighborhood.

Be ready to change your tuner settings when it rains!

VERY SHORT WIRES

Don't underestimate the value of an 8-10 foot wire placed randomly in your shack. I tried this as I was writing this Chapter -- just to keep my money where my mouth was!

The first thing I found on my workbench was a roll of #22 hookup wire. I unwound a few feet without measuring, and attached one end to an antenna tuner. The other end, with the remainder of the coil still attached, was tossed on the back of the bench. Perhaps ten feet were unreeled and the wire was slightly tangled.

I tuned up on 40-meter cw with about 100 watts input, and the first CQ I heard was from VE1WF. Don gave me a 579 report and we had a nice chat. I don't think he really believes what I was using for an antenna ....

METAL SHELVING

Jim, K3**, used metal utility shelves he had assembled and covered to make very nice book and knicknack holders. By this time I don't have to tell you the rest -- he connected the shelves to his rig thorough a tuner and worked instant DXCC ... well, not quite ... but by now you have the picture.

DO YOU GET IT?

"It" is the realization that practically any metal object, anywhere, can be used as an antenna.

It is not a matter of "Will it work?" It is more a matter of "How well will it work compared to something else?"

Obviously, an indoor bedspring antenna will not consistently produce the signal reports and rare DX that a full-sized dipole, outdoors and in the clear, will pull in. But I guarantee that you will be pleasantly surprised at the results you do get.

CHAPTER NINE: TUNING YOUR RIG

Manufacturers and article writers do a good job of telling you how to tune up your rig into a standard load, but I haven't seen much lately in the way of a step-by-step procedure for tuning up with an antenna tuner. Since the use of an antenna tuner is a basic premise throughout this book, I have included a detailed tuneup procedure.

CHECK YOUR SETUP

Before you begin the tuneup procedure doublecheck everything -- connections, switch settings, antenna, and dummy load. Read the manufacturer's instructions and become familiar with them.

MAKE A CHART

You will only have to go through this tuner procedure one time for each antenna and each band. To make things easy, work up a little chart like the one shown and enter each set of readings into it. This will make band changing and later tuneups a breeze.

Make entries for the WARC bands and the 160-meter band if you plan to operate them. When the chart is complete, post it in a spot that is easily seen from your operating position. Nothing is more frustrating than to switch to a different band, hear a rare DX station, and have to fumble around when tuning up. Some hams, mostly contest fanatics, operate separate rigs for each band -- an effective, if expensive, solution!

TABLE ONE: CHART OF ANTENNA TUNER SETTINGS

BAND	SETTINGS		
	L	C1	C2
80			
40			
20			
15			
10			

INITIAL TUNEUP

Conect the output of your transmitter to the dummy load. This can be done either directly, or through your tuner's antenna switch (if it has one). Start at either 10 or 80 meters and practice tuning up your rig into the dummy load. Follow the manufacturer's procedure, and repeat it until it comes naturally. Remember to use the relative power indicator on your SWR meter as an RF output indication during tuneup.

Make a note of the transmitter control that increases and decreases your RF output. It is variously called RF LEVEL or CARRIER. There may be others -- check your manual. It is not the DRIVE control! Older rigs may not have one.

TUNING UP

If the instructions that follow seem involved, they're not -- just thorough! Remember that you only have to do this once for each band and each antenna ... if you remember to write down the tuner settings.

1. Adjust your antenna tuner: set the coil switch or tap to midpoint (or the correct band, if indicated). Set the capacitor(s) to midpoint.

2. Switch the transmitter output from the dummy load to the antenna, through the tuner.

3. Tune your rig to an unoccupied part of the band. It's a good idea to set the frequency to the middle of the subband you're likely to be operating the most -- CW, General phone, Novice, etc. This way the tuner settings will produce a wider useful range, even for very short, narrow-band antennas.

4. Increase the SENSITIVITY control of you SWR bridge to about midpoint. Be sure the meter is set to read in the FORWARD position.

NOTE: When you are tuning up, you will be changing the SENSITIVITY control to produce good readings, and also to prevent the meter from becoming pinned, which can damage it.

5. Turn the CARRIER or RF LEVEL control (if your rig has one) for minimum. output. Place your transmitter in the tuneup mode recommended by the manufacturer.

6. Turn the transmitter to TRANSMIT or TUNE. If you have no CARRIER or similar control, adjust the PLATE TUNE control immediately for the dip and then adjust for minimum plate current.

7. For rigs with tube finals, adjust PLATE TUNE for maximum RF output.

8. If necessary, increase the SWR SENSITIVITY control and/or the transmitter CARRIER control to obtain at least a one-half scale. reading on the SWR meter.

NOTE: Throughout this procedure, do not allow the rig to transmit for more than about one minute at low plate current, or more than a few seconds at moderate to high current, especially when the final is out of resonance. Follow the manufacturer's cautions. In any case it is good practice to make all adjustments with the rig operated at the lowest power that permits full-scale SWR meter readings.

9. Switch the SWR meter to read REVERSE power. Note the meter reading.

10. Stop transmitting and change the coil switch position or tap by one unit. Read the meter. Continue to do this, changing the switch setting or tap by one unit each time. One of the switch settings will cause a distinct drop in the REVERSE meter reading. This is the coil setting you want! Record it.

11. Adjust the capacitor(s) to obtain the lowest reverse power reading. If your tuner has two capacitors, adjust the one on the transmitter side of the coil first. The two capacitors will interact somewhat.

12. Check your SWR by returning the meter to the FORWARD power position and adjusting meter sensitivity until a full-scale reading is obtained. You may have to increase transmitter power slightly to obtain a full-scale reading.

Now switch the SWR meter to read REVERSE or REFLECTED power and read your SWR. If it is less than 2, you're in business! You will probably want to fiddle with the capacitors to get the minimum possible SWR, but it's not necessary.

Write down the tuner settings for this band on your handy chart. Next time, just set the tuner and tune up.

IMPORTANT NOTE

Most antenna tuners will give you two low-SWR points: a real one, and a fake one. You can tell the fake one by checking your power output as measured on the FORWARD meter setting. The real setting will indicate a significantly higher power output than the fake one.

NEVER USE THE LOW-OUTPUT SETTING. IT ENHANCES HARMONICS AND CAUSES OUT-OF-BAND SIGNALS AND TVI.

IN CONCLUSION

We will end this Chapter with a few more words about the care and feeding of your antenna tuner.

One method for finding approximate tuner settings that I have seen in print is the receiver noise method. Here, the antenna tuner is adjusted -- coil first, capacitors next -- until the receiver noise is loudest. You may find that this method works well for you; I've never been able to get it to work satisfactorily.

Antennas that are short compared to the frequency of operation present capacitive reactance which must be compensated for by inductive reactance in the antenna tuner. Further, long antennas present inductive reactance that must be cancelled by capacitive reactance in the tuner. This information from the theory (sorry) gives us a rule of thumb:

RULE OF THUMB: A SHORT ANTENNA WILL REQUIRE A HIGH INDUCTOR SETTING. A LONG ANTENNA WILL REQUIRE A LOW INDUCTOR SETTING AND LOTS OF CAPACITANCE.

Remembering this rule of thumb will be a big help in getting approximate settings for extremely short or long antennas. It will also give you an idea when to add an extra loading coil, and when to try a capacitor to tame an unruly antenna. Keep the operating frequency in mind -- a forty-meter antenna is short for 80 meters, and quite long for 10 meters.

CHAPTER TEN: RF INTERFERENCE (RFI)

This Chapter might be titled, "You are 20 over 9 on Johnny Carson, OM."

Every ham who every had an interference complaint cringes reflexively whenevery the phone or doorbell rings and he is on the air. RFI has given hams nightmares since the days when spark-gap transmitters were used and the problem shows no signs of going away. In fact, the new home-entertainment devices, with built-in microprocessors and digital widgets, only make the problem more widespread and more damnably complex.

Most of us know that if we are operating a clean, legal station the problem is really the fault of the affected equipment. Forget it. The argument that your equipment is licensed and operating within FCC limits has been challenged in local courts and, in a few tragic instances, discarded. Besides, in an apartment or other restricted situation, what the landlord and neighbors think -- as well as what the lease says -- is what will affect your operation.

So if you have any ideas about claiming your right to operate, either set them aside or take up a new hobby. It's as simple as that.

The key to hassle-free operation is prevention. With such gloomy facts facing us, we see that our goal is not to cause the interference in the first place. This, coupled with unseen antennas and equipment, is the key to successful apartment operation.

Most RFI problems can be greatly reduced, if not eliminated, at the ham's end. Because we are dealing with prevention, little will be said about curing

the problem at the interference end. This opportunity doesn't come up too often in apartment environments. Should you be so lucky (or have such considerate neighbors), I refer you to the Radio Amateur's Handbook for information on RFI-proofing home entertainment devices. Read the most recent edition of the Handbook; new research into RFI has produced major advances in this field.

Now, let's examine the causes of RFI.

RFI gets from your rig to your neighbor's equipment in one of two general ways:

Radiation

AC power-line transmission

In apartment buildings there is a third route: transmission through a common ground system, as mentioned in Chapter Seven.

Let's examine these causes one at a time.

RADIATION

Most commercial radio and television receivers on the market today are not capable of rejecting strong signals outside their own passbands. In the common jargon, they are as broad as a barn door. This means that your legal signal, if it is strong enough, can blitz through the device, overriding its front-end (if it has one), and getting into the detector and amplification stages. Your signal can also "ride through" a television or radio's IF stages or get detected directly in the audio circuitry. Stereos and electronic

organs suffer from the same problems in their audio stages -- pickup can even occur in the speaker wires, feed back to the audio stages and pump back out again, right in the middle of The Maudlin Strings Play Aesop's Fables.

Regardless of how your signal enters your neighbor's electronic equipment, the preventive methods are pretty much the same. I am deliberately not associating any particular kind of interference with a single preventive method -- if you want to stay on the air you'll take all the precautions!

LOW PASS FILTERING

Buy a good low pass filter from a reputable manufacturer. There are several on the market. This is not the place to buy junk -- get the best. Filters sold by Brand X make fine paper weights -- you're better off using the money to buy movie tickets. You'll be seeing a lot of films after the landlord shuts you down.

Install the low pass filter as described in Chapter Two. Follow the instructions carefully; again, this is not the place to skimp.

TUNING UP

Know your transmitter and antenna tuner. Practice tuning up into a dummy load until you have it down pat, then go on the air. An improperly-tuned rig can enhance parasitic oscillations and harmonics, putting out an illegal -- and RFI-producing -- signal. Proper tuneup is covered in Chapter Nine and in the standard texts; here are some points to keep in mind.

Observe the plate current and power output meters while tuning up. If the plate-current dip doesn't coincide with maximum power output you rig is not neutralized, or has other problems. Don't go on the air until it's fixed.

Adjust your antenna tuner as described in Chapter Nine. Many tuners will produce two low-SWR settings: one setting results in about the expected power output for the rig, the other in greatly-reduced output. Never go on the air with the tuner set in the low-output configuration.

The same goes for rig tuneup. Stay off the air if you can only produce power output with the PLATE TUNE capacitor set to a different band than the one you are supposed to be on. When this happens you are actually tuning up a harmonic -- a situation that will get you in hot water with the FCC as well as your neighbors.

Never go on the air if there is anything odd about the way your rig or tuner is behaving. The place to check out "glitches" is on the dummy load.

OPERATION

On SSB, make sure your mike gain is cranked back to give, at most, the manufacturer's plate current or ALC peak value on voice peaks. Using more gain will not give your signal more punch; it will produce splatter and distortion and may get you a punch in the nose from an irate neighbor. Distortion makes you hard to understand. Splatter produces a wide signal that dumps electronic garbage up and down the band, produces RFI, and can bring you a note from the Friendly Communications Commission. A poor bargain! Look at your output with a scope if you can. If you can't, have another ham listen to your audio and get an honest report.

All this goes double if you are using any sort of speech processing -- including those built into some rigs. Today's speech-enhancing devices come in many flavors. Most are excellent station accessories that give your SSB signal more punch for fewer dollars. But, improperly used, they can screw up

your signal beyond belief. Too much processor gain will multiply splatter, distortion, and RFI problems many times over. Read the instructions supplied with your processor and follow them.

SHIELDING

Most modern rigs are RFI-shielded quite well -- but give them a chance! Don't operate your rig with the cabinet removed or partially removed. If your transmitter has a lid or panel that opens for service, make sure it is shut tightly during operation. The transmitter has been designed to operate with the cabinet closed; it is not necessary to open it for additional cooling. (Should extreme operating conditions exist, such as high room temperature combined with contest operation and speech processing, use a small fan to cool the transmitter. Position the fan to pull air through the cabinet, never to push it in.)

Even a very small opening in the transmitter causes RFI "leaks."

AC LINE TRANSMISSION

RFI often occurs in different apartments in the same building as a result of RF energy transmitted from your rig to the affected appliances through ac power lines. In this case prevention is a bit simpler. Buy or build a good ac line filter for your rig and use it. Be sure it isolates the entire rig from the ac line, not just the transmitter or transceiver.

RULE OF THUMB: FOR EFFECTIVE RFI PREVENTION, FILTER EVERYTHING.

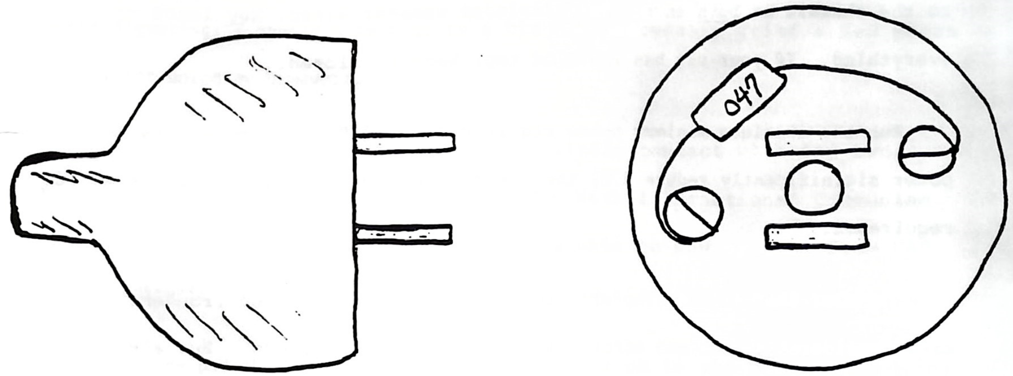
The filter must have a current rating that meets or (preferably) exceeds the current drawn by all the equipment it serves. Again, don't buy junk. This is not the place to economize. Some filters on the popular or CB market aren't worth the money and can get you kicked off the air, all your effort wasted. At this writing, at least one reputable manufacturer offers multiple-plug outlet strips that are individually filtered, and a model with a single filter. The multiple-filter model also filters your components (keyer, computer) fom each other, which is a real plus and worth the few extra dollars.

A clever trick will help reduce ac-line related RFI in your own apartment. Get several old-style ac power plugs , and the same number of .01 or .05 uf, 1 or 2 KV disk ceramic capacitors. Connect the capacitors directly across each plug's screw terminals as shown in Figure 10-1. This forms a simple RF filter.

Now turn on a radio, tv, or other device in your own apartment, make some short transmissions, and insert your plugs randomly in unused outlets until the interference is reduced. This little filter effectively detunes the power wiring in your apartment. In addition to reducing local interference, it also prevents your precious RF from being absorbed into the line and lost.

IF YOU GET COMPLAINTS

Proceed very carefully, and read Chapter Eleven. In most apartment situations the tenants do not have the rights of a homeowner. In fact, even the right of a homeowner to run a legal station has recently been challenged in court. If another tenant comes to you instead of going to the landlord to complain, consider yourself lucky.



Old-fashioned ac power plug
(available at hardware stores)

Connect .047 uf, 1kv
capacitor across contacts

FIGURE 10-1: SIMPLE AC LINE FILTER

IN SUMMARY

Shield everything. Every wire that enters or exits a piece of equipment should be made of small coaxial cable, with the braid grounded to the chassis at both ends. This includes speaker wires, key leads -- everything. If your rig has a hinged top, keep it closed.

Run the absolute minimum power required for a QSO. Not only does lower power siginificantly reduce RFI, the use of minimum necessary power is an FCC requirement.

Remember that eliminating RFI problems in an apartment environment may take considerable time and effort, and will cost a few bucks. But also remember this: If you are shut down for RFI complaints, the fact that you are operating a legal station does not make one bit of difference.

The hard fact is that all the effort must come from you.

CHAPTER ELEVEN: LANDLORDS, TENANTS, AND OTHER NICE PEOPLE

In this chapter we'll examine landlords, tenants, and housing types in general and discuss methods of dealing with them. The information is well worth digesting; I caused myself quite a bit of unnecessary grief a few years ago by not doing my homework.

I moved into a two-family house, and had little contact with its owner. My previous landlord had equated amateur radio with international communism and the black plague, and the look on his face when he saw my QSLs from UA9 (Soviet Siberia) and CO2 (Cuba) was something I won't soon forget.

In my new pad the rig went into a convenient nook in the bedroom. I strung a wire around some rafters above my part of the house, took the measures I've described in this book, and was in business. Business was very good. In a few weeks I had worked over fifty countries, including 3B8CF and OD5LX, on my favorite 20 CW. There wasn't a peep from my downstairs neighbors; in fact, I often heard the themes from popular TV shows drifting upstairs after I took off my headphones.

One fall day I came home from work and was met at the door by my landlord. As my heart dropped into my shoes he told me there had been a phone call. Smoke had been seen coming out of my windows. When he went inside the apartment to check (it was a false alarm) he saw some "radio stuff" in the bedroom.

I quickly muttered something about working in the electronics industry, which I was doing at the time.

"Oh," he said. "But are you one of those ham radio operators?"

"Yes, but ..." I broke off into mumbles and gestures.

"You know," my landlord said, "I've always been interested in that stuff. Sometime would you, ah ... show me how it's done?"

He was a talented chap and soon had a Novice license. By then I had three full-sized inverted vees and a vertical in his back yard.

I doubt that this story is too commonplace. But it illustrates a very important point for the apartment ham: know your landlord! And don't make assumptions of any sort. You might save yourself a lot of trouble.

LANDLORDS

Before you sign a lease, have a talk with your prospective landlord. Discuss other matters, and try to feel him out indirectly and discover his attitudes toward ham radio. Be indirect, because there is no point in tipping him off if he is hostile.

To be fair, most landlords understand nothing about ham radio or any radio. They equate us with CB operators (terrible thought!) and most landlords have been burned at one time or another. Find out the score if you can, since an understanding landlord can waive lease restrictions. Don't sign the lease until you are ready -- it is far easier to get an unsigned lease changed. Once you sign, you are stuck.

If the landlord is open to reasonable discussion, you will have to educate him. To do so effectively, you must understand his side of the story (yes, he has one). Here are the two things landlords fear:

1. Tenants moving out, leaving empty apartments

2. Property damage.

If you can demonstrate to your prospective landlord, before the fact, that your operation will neither annoy his other tenants nor damage his property, you have a good shot at approval.

HOW TO PREPARE YOUR CASE

Begin by explaining to your landlord the difference between ham radio and other communication types. Bring literature on RFI filters, articles, and related material with INTERFERENCE PREVENTION clearly marked in big red letters. Using this material as background, show him how his tenants will be unaware of your operation. If you've sized up your man and think it might help, also include a few abstruse technical articles with lots of equations. Refer to them casually, as though everyone knew about such things.

Discuss your extensive precautions and preparation until he yawns, sits upright, and asks, "But will it damage the foundation?"

To address the property-damage objection, you should be armed with carefully-drawn plans of your proposed installation. Always show him, never tell him. Point out that structural damage is not only unlikely, but also that his petunias will be safe and sound.

A landlord's fear of damage to his foundation sounds like a silly exaggeration to us. But until you have seen and heard it firsthand, you simply will not believe the misconceptions of the the average person.

If you can win your prospective landlord over to your cause, great -- but you must stick to your end of the bargain. His wrath will be great (and your eviction swift) if he puts his confidence in you and a kid gets burned playing jump rope with your feedline.

LEASES

Winning a landlord's approval is not easy. Most feel they have nothin to gain and a lot to lose by permitting large dogs, rowdy parties, and those radio hams on the premises. In any event, don't move anywhere before you read the lease in advance. That's important:

READ THE LEASE FIRST! EVERY WORD!

In fact, hiring a lawyer to comb through the fine print and tell you the legal meaning of all the terms is well worth the money, unless you are:

1. A lawyer yourself
2. Fond of taking insane risks
3. Insane

If your lease and landlord are poised with thumbs resolutely down, don't give up. A good bit of this book is devoted to the fine art of operating anyway: safely, and without inconveniencing your neighbors.

TENANTS

Whether you are operating under cover or not, you have absolutely got to keep your neighbors happy. Nothing is more embarrassing than having an angry landlord appear at your door (just when 9N1MM is standing by for you) with hurt and anger written on his honest face. "I thought you told me --" he begins.

You did tell him. In fact, you assured him. But now it seems that old Mrs. Feedthrough next door has been getting that ham thing in the middle of her favorite soap opera, and the teevee's all that woman's got these days. What's the story?

You'd better think of a good story, and fast. I know -- it happened to me and I got shut down.

Encourage good all-around relationships with your neighbors, both in apartment and other situations. I recently moved into a new area and proudly put up my first beam in 25 years on the air. Being on good terms with my next-door neighbor has worked wonders; he is an old timer in the area and runs interference for me with other, less social families. A few of these people looked troubled when the six-element monster was hauled into place. Their fears were allayed somewhat when they saw my neighbor pulling one of the tag lines. Being taciturn New England types, if they have questions they ask him -- and he learned his answers from me.

The importance of this sort of relationship with at least one well-known neighbor cannot be overemphasized. You have more than RFI and antennas to think about if you are operating incognito. QSLs in your mail, guests glimpsing the rig or antenna wires, and your kids talking to other kids are just a few considerations. I have found it all but impossible to operate in

an apartment without someone knowing about it. If you have laid the proper groundwork you stand an excellent chance of being home free. If not, small annoyances that might have been taken care of can grow into a complaint to the landlord or building manager.

With a complaint in hand, even the landlord who has looked the other way has to act.

Here are some tried-and-true methods of dealing with neighbors who insist that the interference is your fault:

STEP 1: Invite them over to watch your TV while you transmit. This is often a great time to convince them than an inexpensive TV filter (which you have on your TV set -- and in your tool box) might not be a bad idea for them.

STEP 2: If practical, follow the first method up by demonstrating the rig (if you work SSB). Even if your QSO is only with a an operator in the next state it will make a big impression. A word of warning: Murphy's Law operates here. Although you might normally get two or three answers to every CQ, when visitors are present it becomes very difficult to contact anybody, anywhere.

STEP 3: Explain the public-service aspect of out hobby and its usefullness during emergencies. Most people have vaguely heard of this. Get the public-relations packet from ARRL ahead of time and show pictures and headlines. This helps more than you might think. People hate to interfere with public service activities. You can do this even if you have no intention whatsoever of doing public service work.

STEP 4: At some point, present your amateur license. (If it's a Novice license, cover that part with your thumb.) Note that the license has been issued by the Federal Communications Commission, an agency of the US Government, and that you are operating under their jurisdiction. Be sure to display you awards, ARRL membership, certificates, whatever looks official. What you are doing is building up the impression of an "official" operation in your neighbors' minds. By all means, play down the hobby aspect.

If you have unreasonable neighbors you may be in hot water. Hope and pray that the RFI-prevention methods you've applied work one-hundred percent. If they do not, and your neighbors complain directly to the landlord, there is very little you can do. You want to stop it before it gets to that point.

The next section will help if you get desperate.

LAST RESORTS

The tactics I'm about to describe might be thought of as shady by some. I don't recommend that you use them. But you paid good money for this book and I want you to know every option. Of course, I've never done anything like this!

Put your rig in order first. Make sure you are clean and legal in every respect.

If you don't own a memory keyer borrow one from a ham friend. Program a random series of test letters into the keyer memory, followed by TEST and your call. YOU CANNOT LEGALLY SEND UNIDENTIFIED TRANSMISSIONS. Set the keyer

function selector to Repeat, and check the rig to be certain it will run safely for a couple of minutes without attendance.

Tune the rig to a portion of a band where you won't interfere with other stations. Sitting on Radio Moscow on forty meters won't bother anybody.

Fire up the rig and go to see your unreasonable neighbor. Ask him when he last heard the interference. What's that -- he's getting it right now? With you standing at his door?

Now you can be sympathetic and shake you head about CB operators, leaky power lines, and the like. Offer to help him eliminate the RFI with simple filters. Curse those CB operators!

If your neighbor is still suspicious, one further step can be taken. Go back to your own apartment to "check things out." Tell him to stop by the next evening, whether he is getting interference or not.

The next night, put the microphone out of sight and tune up the rig on the <u>dummy load</u>. When your neighbor arrives get "on the air" into the dummy. Call a few long CQs. If, when tuning around, you find a CW signal strong enough to ride through into the receiver, have a "contact." In the meantime someone at your neighbor's place should be verifying that the interference is not present.

These are desperate tactics and, as I said, I don't recommend you use them. They are listed here strictly for information.

They are.

IN SUMMARY

Use <u>all</u> available RFI-prevention techniques -- stop problems before they start. A clean, legal signal minimizes RFI and keeps you in the good graces of the FCC. Approach the landlord ahead of time, if possible. Don't go in blind; prepare a case. Always show instead of telling. Read your lease before signing it and have a good lawyer check it out. Develop friendly associations with yoru neighbors -- you want them to complain to you, not to the landlord.

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Three books I consider essential for every ham's library are:

Orr and Cowan, Wire Antennas. Radio Publications, Inc. Wilton, CT: 1972.

ARRL Staff, ARRL Antenna Book. ARRL, Newington, CT: 1974.

ARRL Staff, Radio Amateur's Handbook, 1981 Edition. ARRL, Newington, CT: 1981.

These two books are written for a highly-technical audience; however, they contain a gold mine of information:

King, Transmission Line Theory. Dover Publications, NY: 1965.

Kraus, Antennas. McGraw Hill, NY: 1950.

About the Author

Dan Fox, W2IQD, has been an active amateur for 25 years and has operated from apartments and other restricted environments for 24 of those years. His previous calls were K3ACD and W1GNZ. Dan holds an M.S. degree in physics and an Amateur Extra Class license. He lives in New Hampshire with his wife and five children, where he is a full-time writer.